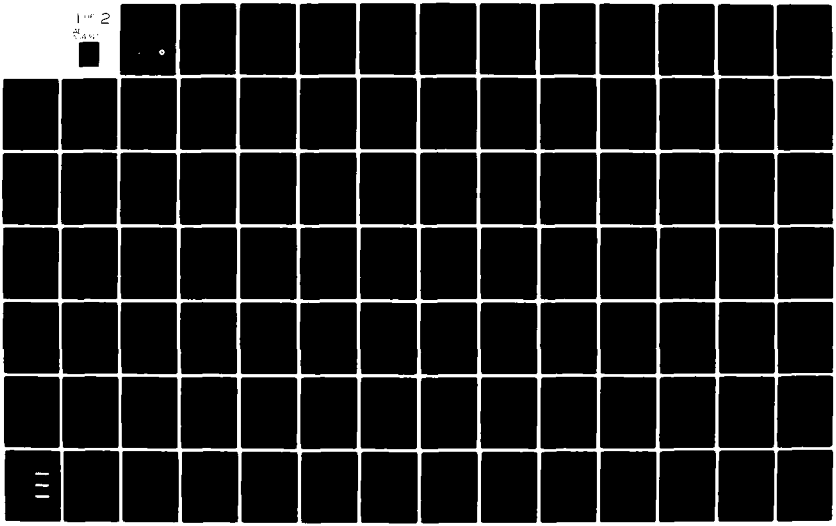
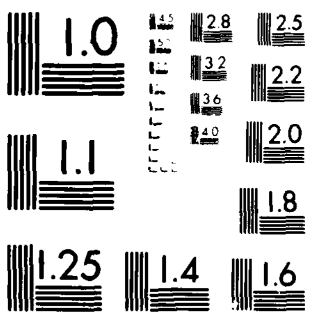
AD-A114 747 NATIONAL MARITIME RESEARCH CENTER KINGS POINT NY COM--ETC F/G 5/9
SIMULATORS FOR MARINER TRAINING AND LICENSING. PHASE 3: INVESTI--ETC(U)
DEC 81 T J HAMMELL, J W GYNTHER, J A GRASSO
UNCLASSIFIED CAORF50-8004-01 USCG-D-07-82 NL

1 of 2





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A

(12)

CG-D-07-82

CAORF 50-8004-01

TECHNICAL REPORT

SIMULATORS FOR MARINER TRAINING AND LICENSING

PHASE 3: INVESTIGATION OF HORIZONTAL FIELD OF VIEW REQUIREMENTS FOR SIMULATOR-BASED TRAINING OF MARITIME CADETS

Prepared By

NATIONAL MARITIME RESEARCH CENTER
KINGS POINT, NEW YORK 11024

DECEMBER 1981

Document is available to the public through the
National Technical Information Service
Springfield, Virginia 22151

Prepared For

U.S.DEPARTMENT OF COMMERCE
MARITIME ADMINISTRATION
OFFICE OF RESEARCH AND DEVELOPMENT
WASHINGTON, D.C. 20230

U.S.DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD
OFFICE OF RESEARCH AND DEVELOPMENT
WASHINGTON, D.C. 20590

82 05 24 049

CG-D-07-82 SIMULATOR FIELD OF VIEW FOR MARITIME CADETS DECEMBER 1981

BIBLIOGRAPHIC DATA SHEET	1. Report No. CG-D-07-82	2.	3. Recipient's Accession No.

4. Title and Subtitle	5. Report Date
Simulators for Mariner Training and Licensing Phase 3: Investigation of Horizontal Field of View Requirements for Simulator Based Training of Maritime Cadets	December 1981
	6.
7. Author(s) T.J.Hammell, J.W.Gynther, J.A.Grasso, and D.C.Lentz	8. Performing Organization Report No. CAORF 50-8004-01
9. Performing Organization Name and Address National Maritime Research Center, Kings Point, New York 11024	10. Project/Task/Work Unit No.
	11. Contract/Grant No.
12. Sponsoring Organization Name and Address Office of Research and Development Maritime Administration U.S.Dept. of Commerce Washington, D.C. 20230 Office of Research and Development U.S.Coast Guard U.S.Department of Transportation Washington, D.C. 20590	13. Type of Report & Period Covered CAORF Technical Report
	14.

15. Supplementary Notes

Project Managers: Dr. John Gardenier, U.S.C.G.; Joseph Puglisi, CAORF; and Joseph Walsh, MarAd
Project Monitors: Arthur Friedberg, MarAd, CDR W. Robert Arnet, U.S.C.G.

16. Abstracts

Merchant vessel bridge/shiphandling simulators have become increasingly attractive as a possible supplement to existing training programs for maritime cadets. In the spring of 1979, the Computer Aided Operations Research Facility (CAORF) developed and coordinated the prototype cadet simulator-based training program in the United States. (For a description of the prototype program, see NMRC reports entitled "Simulators for Mariner Training and Licensing Phase 2: Investigation of Simulator-Based Training for Maritime Cadets.") This document describes the conduct and evaluation of the second offering of the course in the spring of 1980. The primary research issue investigated during this second training program was the horizontal field of view requirements for a maritime cadet simulator.

17. Key Words and Document Analysis. 17a. Descriptors

Maritime cadet training
Simulators
Training Objectives
Training Effectiveness
Horizontal field of view

17b Identifiers/Open-Ended Items

17c. COSATI Field/Group

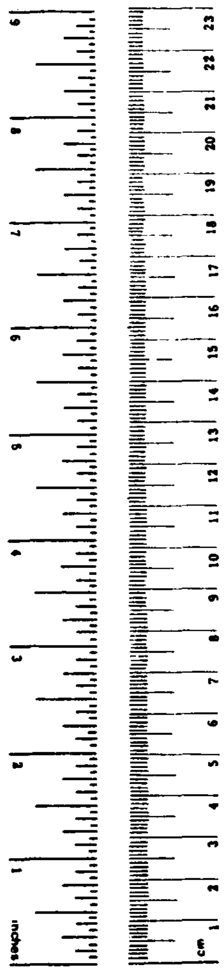
18. Availability Statement	19. Security Classification (This Report)	21. No. of Pages
Approved for Release NTIS Springfield, Virginia	UNCLASSIFIED	192
	20. Security Classification (This Page) UNCLASSIFIED	22. Price

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

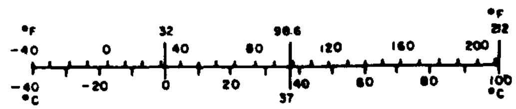
Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



ACKNOWLEDGEMENTS

The authors wish to acknowledge the invaluable assistance of the U.S. Merchant Marine Academy staff, particularly CAPT P. Nazzaro and CDR R. Meurn, in the conduct of this experimental cadet simulator-based training program. Their help was essential to the success of the project.

TABLE OF CONTENTS

Section	Title	Page
	EXECUTIVE SUMMARY	ix
1	INTRODUCTION	1
	1.1 Background	1
	1.2 Phase 1 and 2	1
	1.3 Cadet Training Experiment – Phase 2	2
	1.4 Cadet Training Experiment – Phase 3	4
2	METHODOLOGY	5
	2.1 Approach	5
	2.2 Cadets/Trainees	5
	2.3 Experimental Variable Selection	6
	2.4 Simulator	6
	2.5 Experimental Design	7
	2.6 Tests	7
	2.7 Training Program Content	9
3	RESULTS AND DISCUSSION – RULES OF THE ROAD RELATED SKILLS	24
	3.1 General	24
	3.2 Input Characteristics	24
	3.3 Training Program Effectiveness	28
	3.4 Training Under a 120-Degree Field of View Versus Training Under a 240-Degree Field of View	33
4.	RESULTS AND DISCUSSION – PORT APPROACH RELATED SKILLS	35
	4.1 General	35
	4.2 Input Characteristics	35
	4.3 Training Effectiveness	36
	4.4 Training Under a 120-Degree Field of View Versus Training Under a 240-Degree Field of View	38
5.	CONCLUSIONS	40
	5.1 General	40
	5.2 Entering 3rd Mate Characteristics	40
	5.3 Training Effectiveness	41
	5.4 Summary	43
6.	RECOMMENDATIONS	44
	6.1 General	44
	6.2 Continuation of Cadet Training Research	44
	6.3 Simulator Design Characteristics	45
	6.4 Summary	46

TABLE OF CONTENTS (Continued)

Section	Title	Page
Appendix A	Training and Testing Scenarios	A-1
Appendix B	Written Tests for Course D460	B-1
Appendix C	Student Handouts	C-1
Appendix D	Sample Instructor's Guide	D-1
Appendix E	Manual Data Collection Sheets	E-1
Appendix F	Results: Rules of the Road	F-1
Appendix G	Results: Port Approach	G-1
Appendix H	Student Debriefing Questionnaire	H-1
Appendix I	Analysis of Student Debriefing Questionnaire and Essay	I-1
Appendix J	Subject Demographics	J-1
	BIBLIOGRAPHY	K-1

LIST OF ILLUSTRATIONS

Figure	Title	Page
1	Representative Weekly Schedule – Odd Week	10
2	Representative Weekly Schedule – Even Week	11
3	Maneuver Familiarization Diagram	15
4	Instructor's Check-Off List	18
5	Port Approach Area	19
6	Scenario 1 (Test Scenario)	25
7	Scenario 2 (Test Scenario)	26
8	Training Effectiveness – Closest Point of Approach	29
9	Training Effectiveness – Mean Range of Maneuver	30
10	Training Effectiveness – Mean Number of Visual Bearings	32
11	Training Effectiveness – Mean Number of Radar Requests	32
12	Posttest Comparison – Mean Number of Visual Bearings	34
13	Training Effectiveness – Maximum Track Deviation (Turn 1)	37
14	Training Effectiveness – Mean Initial Centerline Offset (Turn 3)	37

LIST OF TABLES

Table	Title	Page
1	Summary of Experimental Issues and Approach	8
2	Course Structure – Group A (240-Degree Field of View)	12
3	Course Structure – Group B (120- Degree Field of View	13
4	Detailed Training Objectives for the Prototype Cadet Training Program	17
5	Port Approach Navigation Accuracy (Phase 3)	36
6	Port Approach Success Rate	38
7	Port Approach Navigation Fix Accuracy	39

EXECUTIVE SUMMARY

BACKGROUND

The Training and Licensing project, which began in late 1977, is in its third phase. The first phase effort, the findings of which are detailed in an extensive three-volume report by Hammell, Williams, Grasso, and Evans (1979), developed the foundation on which the latter two phases have been built. A substantial portion of the Phase 1 effort was devoted to analysis of the compiled information with regard to delineating the role of the simulator. The Phase 1 report contains an extensive analysis, based on currently available information of alternative simulator-based training system alternative design characteristics. In addition, it identifies the specific functional objectives to be achieved by deck officer training and develops a training program structure consisting of 12 training modules. The structure proposes a technique for diagnostic analysis of a deck officer's skills, such that training can be tailored according to each individual's needs, thus eliminating unnecessary training. Lastly, the analysis resulted in the identification of gaps in current knowledge regarding the design and use of simulators for deck officer training. The ensuing recommendations identified specific issues in the following areas for which empirical research should be conducted: (a) simulator characteristics, (b) training program characteristics, and (c) training system cost effectiveness.

Two empirical investigations were conducted during Phase 2: (1) a masters level investigation of simulator/training program characteristics, and (2) a simulator-based maritime academy cadet training course. The first cadet training experiment, a pioneering effort regarding the use of simulator-based training for maritime academy cadets, was designed to investigate the substitution of some amount of simulator-based training in lieu of at-sea training time, with regard to the pending Inter-governmental Maritime Consultative Organization (IMCO) requirement of 12 months at-sea training for cadets. This investigation, which is continuing in Phase 3, was designed to (a) generate information regarding the effectiveness of specific simulator characteristics for the training of cadets (e.g., day versus night visual scene), (b) evaluate the shiphandling skills currently possessed by cadets, (c) evaluate the effectiveness of simulator-based training in improving these skills, and (d) generate information pertaining to other elements of the training system (e.g., distributed versus concentrated training, as an element of training program guidelines).

The third phase of this project, of which this second cadet experiment is a subset, is expected to be completed by mid-1981. Its thrust is twofold: (a) the development of training system acceptance criteria for use by the U.S. Coast Guard to evaluate simulator-based training programs as acceptable for partial satisfaction of some license requirement; and (b) the development of simulator functional design specifications and training program guidelines for maritime academy cadet simulator-based training. This document summarizes the second prototype cadet training program/experiment and its findings.

EXPERIMENTAL OBJECTIVES

This investigative training program had the following objectives:

- Evaluate the shiphandling-related skills level of cadets who have completed their at-sea training and are ready to assume duties of a 3rd mate after

successfully completing the written examination. These are the entry-level skills of new 3rd mates.

- Evaluate the effectiveness of a simulator-based prototype training program for improving the skills of a cadet/3rd mate.

- Evaluate the training effectiveness of a 120-degree field of view versus a 240-degree field of view on the simulator for skills related to rules of the road.

- Evaluate the training effectiveness of a 120-degree field of view versus a 240-degree field of view on the simulator for skills related to port approach.

- Provide a simulator-based training course in shiphandling for cadets.

TRAINING PROGRAM

The prototype cadet simulator-based training program was divided into two independent training modules: (a) international rules of the road and (b) port approach planning. These two modules were chosen to represent potential utilization of simulator-based training at the cadet level. The international rules of the road training module was conducted during the first 5 weeks of a 9-week program. The second 4 weeks covered the port approach planning training module.

Both training modules had a 50/50 mix of classroom and simulator time. One hour of classroom time was followed by 1.5 hours of simulator time, which were in turn followed by a 30-minute feedback classroom session.

Each group of cadets was subdivided into two three-man teams for training. One three-man team stood watch on the bridge during each scenario run. The three-man team was comprised of:

- A senior watch officer
- A radar observer
- A navigator

The cadets rotated positions in the team after each scenario. While one bridge team was on the bridge, the other bridge team in the group was viewing the scenario via television monitors at the human factors station. An instructor was providing evaluative commentary to these "off-watch" cadets during this time.

Instructors for the training program were experienced mariners from the Computer Aided Operations Research Facility (CAORF) staff and the U.S. Merchant Marine Academy, Nautical Science Department Staff.

TRAINEES

The two groups of six trainees each (i.e., 12 cadets) were from the U.S. Merchant Marine Academy (Kings Point). This sample may be representative of first class cadets not only at Kings Point but at the other maritime academies as well. Since these cadets were evaluated in the spring of their senior year just prior to graduation, it is assumed that the characteristics observed on the pretraining test

scenarios were the characteristics of a representative cadet a few months later upon reporting aboard his first ship as a new 3rd mate.

EXPERIMENT DESCRIPTION

Each of two groups of cadets were trained under a different set of treatment conditions. The treatment conditions were (a) daytime 120-degree field of view and (b) daytime 240-degree field of view. Each group of cadets was administered appropriate test scenarios prior to the commencement of each training module and upon completion of each training module.

Analysis of cadet performance on the pretraining test scenarios provided the information regarding the professional entry skill levels of cadets. Comparison between cadet performance on the pretraining and posttraining test scenarios provided information on the effectiveness of the simulator-based training program. Comparison between the effectiveness of training under the different treatment conditions provided information regarding the relative benefits to be derived from daytime training with a 120-degree field of view and with a 240-degree field of view.

CONCLUSIONS

These conclusions are based on simulator-based training research using 12 cadets from the U.S. Merchant Marine Academy (Kings Point). Statements are made concerning cadet characteristics and cadet training at Kings Point. It should be noted that the experimental sample was small. Hence, the inferences made from these data pertaining to the cadet population as a whole should be viewed cautiously since substantial differences may exist between the sample and the overall population of cadets. Nevertheless, these data do provide an initial objective look at the skills possessed by graduating cadets/3rd mates and the potential effectiveness of simulator-based training programs. A summary of the conclusions of this investigation is presented below:

Entering 3rd Mate Characteristics

- Although no collisions were experienced during the experiment, the closest points of approach (CPAs) achieved with traffic vessels under open-sea conditions, were less than 1 nautical mile on the average and were considered as only marginally acceptable. The instructors felt that substantially larger CPAs should be achieved by 3rd mates on watch in these situations. The achieved CPA represents the culmination of several aspects of man/ship system performance. Several of these contributory aspects of performance that impact the resultant CPA are addressed below. (Supports Phase 2 conclusion.)

- The available information was not fully utilized in evaluating and responding to the developing situations. The cadets overemphasized the radar information while often neglecting the visual information. This may be due to a variety of factors, including (a) heavy emphasis on the radar plotting skills during training, perhaps resulting from a very effective radar training program; (b) underemphasis on visual skills during training; (c) some combination of these factors. (Supports Phase 2 conclusion.)

- Substantial room for improvement was observed in the communication and bridge procedures used by the cadets. Areas for improvement included notification of the master regarding an impending situation, maneuvering orders to the helmsman, and VHF communications. (Supports Phase 2 conclusion.)

<u>Training Effectiveness</u>

- The training program was found to be effective in improving certain cadet skills. Observations of improved cadet skills were in the following groups:
  - Rules of the road perceptive and decisionmaking skills
  - Port approach navigation skills
  - Overall bridge procedures including helm orders, VHF communications, bridge team organization/communications, and notification of the master

  (Supports Phase 2 conclusion.)

- When training open-water rules of the road related skills, cadets trained with 120-degree horizontal field of view exhibited equivalent proficiency in maneuvering their vessels as compared with cadets trained with 240-degree horizontal field of view. No statistically significant differences were observed between the two groups in regards to resultant CPA.

- There may be a danger that cadets trained in open-water rules of the road situations on a simulator with a 120-degree horizontal field of view, may neglect to utilize visual bearings to assist in determining risk of collision for contacts greater than ±60 degrees relative. (See Section 3.4)

- A horizontal field of view of 120 degrees appears to be unsatisfactory when using a simulator-based training program to develop visual position fixing skills in a port approach scenario. The field of view hampered the development of trainee skills relating to (a) the utilization of visual turn bearings and (b) the selection of objects for visual fixes such that their lines of position intersect at appropriate angles, as prescribed by accepted navigation practice. (See Section 4.4)

- There may be a danger that simulator-based training in port approach related skills may not be highly generalizable if it is conducted in a single geographic area. Training port approach skills in only one geographic area may reduce the transferability of such skills to other geographic areas.

- It is the opinion of the cadets that simulator-based training in general, and this program in particular, is of substantial benefit. It was their opinion that the simulator-based training program provides benefit beyond that of at-sea training. They viewed such training as a supplement to at-sea training. (Supports Phase 2 conclusion.)

- Simulator-based training appears to be an effective supplement to at-sea training for cadets. Several shortcomings were observed on entering the experimental training program which would likely be corrected during the initial break-in period at sea. Several of these shortcomings were corrected during the simulator-based training program, underscoring its effectiveness to the at-sea training program. (Supports Phase 2 conclusion.)

RECOMMENDATIONS

The recommendations made as a result of this investigation include the following:

Continuation of Cadet Training Research

- Investigate the extent of the 3rd mate shortcomings identified in this report. Are the proficiency levels identified for Kings Point cadets also representative of the proficiency levels of graduates of the other maritime academies? Administer and analyze the same pretraining test scenarios to a larger sample of cadets to determine the extent of the problem areas identified in this study.

- It is presently postulated that any deficiencies presently observed in a new 3rd mate's performance are being corrected during the mate's initial break-in period on his first vessel. Administer the same test scenarios to 3rd mates with varying amounts of sea time in order to establish the time required for such postgraduate on-the-job training (OJT). This information would also be useful in providing a more objective basis for addressing the "at-sea equivalence issue."

- Request that the radar simulator-based training schools stress the importance of multiple navigational information sources (e.g., visual bearings in addition to radar) in determining risk of collision. For a longer term, investigate the use of a full-mission simulator upon an individual's completion of the radar simulator course to ensure the proper balance between the use of radar information and other navigation information sources.

- Expand the simulator-based training at Kings Point as a prototype training program. This training course was most successful, but it was of limited scope. If it were expanded to encompass more students and additional simulator-based courses (e.g., emergency shiphandling), greater insight could be gained into the problems associated with implementing a simulator-based training program at the maritime academy level.

Simulator Design Characteristics

- The design of future simulators for training open-sea rules of the road related skills should have a horizontal field of view depicting the visual details required in any appropriate scenarios. If a simulator with a 120-degree field of view is employed, there may be a danger that the trainees will neglect taking visual bearings at sea to assist in establishing risk of collision when contacts have a relative bearing of greater than ±60 degrees relative. The training program should attempt to compensate for this potential shortcoming by emphasizing the importance of taking visual bearings for contacts greater than ±60 degrees relative.

- A "binocular effect" similar to that employed during this experiment is recommended for simulator-based open-water rules of the road training but should not be required. (See page 14 for a discussion of the term "binocular effect.") If such a binocular effect is utilized, it should be carefully implemented to limit its capability (i.e., resolution, range) in order to train

the students to utilize binoculars only as a secondary source of navigation information when evaluating risk of collision.

- The design of future simulators for training port approach related skills should have a horizontal field of view substantially larger than 120 degrees in order to ensure the capability of properly developing visual position fixing skills.

- Since the ability to use VHF communications procedures is one skill in which this research revealed near 3rd mates to be deficient and which was readily improved by a simulator-based training program, the design of future simulators for cadet training should have a simulated VHF communications capability.

- Since the ability to properly notify the master of a threat vessel was another deficient skill, the design of future simulators for cadet training should include a remote observation station for the instructor, such that he can simulate at-sea mate-master communications (e.g., when the master is in his cabin). The remote observation station also provided an excellent point from which the instructor could provide an evaluative commentary to those students not involved in the exercise. In addition, it provided the instructors with the opportunity to use the student pretest as a diagnostic scenario, discussing among themselves points to be emphasized during the training program.

- Since this research demonstrated that cadets have a tendency to neglect visual bearings as a means of determining risk of collision, the design of future simulators for cadet training should have the capability for taking visual bearings. In addition, the training program should stress the prudent procedure of utilizing multiple navigational information sources.

SUMMARY

The variety of the conclusions and recommendations made above not only provide additional insight into the effective use of simulator-based training at the cadet level, but also support many of the conclusions and recommendations advanced in the Phase 2 report (Hammell et al, 1981). This investigative effort should continue and expand to generate additional specific information to assist the evaluation and possible implementation of simulator-based training programs for cadets.

SECTION 1

INTRODUCTION

1.1 BACKGROUND

National and international concern has focused on mariner training over the past several years. Such evidence includes the recent Inter-governmental Maritime Consultative Organization (IMCO) Convention on Standards of Training and Watchkeeping. During this convention, the attending nations reached an agreement on substantially altering the training requirements for maritime academy cadets by requiring more at-sea time (i.e., 12 months) prior to obtaining the 3rd mate's license. This requirement would place an additional burden on the presently overloaded U.S. training ships. Therefore, a viable, cost effective alternative of substituting some amount of simulator-based training of cadets for the required at-sea time is being considered. The role of the simulator, however, as part of the training system with reference to the areas of application, the necessary simulator-based system design characteristics, and the actual cost effectiveness of such training must first be determined. Considerable research is required to assist the training experiment designer, operator, and user of the ship bridge/shiphandling simulator. Therefore, the U.S. Maritime Administration and the U.S. Coast Guard jointly embarked on a program to investigate the potential role of the simulator in the mariner training and licensing process. The goal of this program is to develop an information base from which positions, decisions, and actions may be formulated to conduct cost effective simulator-based training and to raise the licensing and qualification standards of mariners.

1.2 PHASES 1 AND 2

The investigative program was divided into three phases. The first phase of this investigation centered on the advanced level deck officer (i.e., chief mate, master). A large information base was assembled addressing deck officer behavior, training technology, and the design and use of shiphandling simulators for training. Although the 3rd mate and cadet training areas were not directly addressed, much of the assembled information is directly relevant (e.g., many 3rd mate tasks were identified).

The second phase of this investigation was an experiment designed on the basis of the Phase 1 findings. The experiment investigated six potentially high cost simulator/training program variables, namely:

- Target maneuverability
  Independent versus canned
- Color visual scene
  Color versus black and white
- Feedback methodology
  Augmented versus nonaugmented
- Time of day
  Daylight versus night
- Horizontal field of view
  240 degrees versus 120 degrees

- Instructor
  Instructor "A" versus instructor "B"

This experiment sought to evaluate the training effectiveness of simulator and training program characteristics in the context of the chief mate/master training level.

It was during this second phase of the Training and Licensing Project that an empirical investigation into the use of shiphandling simulators for cadet training was initiated, drawing upon the assembled information as the foundation.

Two cadet training experiments were planned. The first cadet experiment was conducted as a subset of Phase 2 of the Training and Licensing Project while the second cadet experiment was conducted during the Phase 3 effort.

1.3 CADET TRAINING EXPERIMENT – PHASE 2

The Phase 2 cadet training experiment was the first prototype cadet simulator-based training course to be developed and conducted in the United States. It was conducted at the Computer Aided Operations Research Facility (CAORF) in 1979. Three groups of cadets participated in this program; two groups from the U.S. Merchant Marine Academy, Kings Point, New York; and one from the New York State Maritime Academy, Fort Schuyler, New York.

Several issues were under investigation during this experiment, including: (a) the shiphandling skill level possessed by a graduating cadet, (b) the effectiveness of a simulator-based training program for improving a cadet's skills, and (c) the cost effectiveness of alternative simulator and training methodology variables regarding cadet training.

One simulator variable and one training methodology variable were selected for experimental investigation. The simulator variable selected was day-only conditions versus night-only conditions. Several existing simulators represent the two extremes of this variable. However, the alternatives can represent large differences in simulator cost. On the basis of cost, therefore, this simulator variable seemed to be a logical choice to be investigated for a cadet simulator.

The training methodology variable selected for investigation was distributed training (i.e., one Kings Point unit of training spread over a 6-week period) versus concentrated training (i.e., the Fort Schuyler one unit of training concentrated into a 1-week period). This training methodology variable can definitely represent wide cost variations in the implementation of training. This variable is also of interest to the international community and would likely be of significant interest in the use of a simulator for cadet training.

The training program which was developed and implemented at CAORF was divided into two units: (a) rules of the road and (b) port approach planning. Each unit was developed as an independent training module specifically designed for cadet training. The rules of the road unit consisted of a mix of classroom and simulator time. It addressed vessel handling when in three potential collision situations: (a) cross situation with ownship as the giveway vessel; (b) crossing situation with ownship as the stand-on vessel, in which the giveway vessel did not maneuver; and (c) meeting/ambiguous situation. Both of the Kings Point groups and the Fort Schuyler group received this unit of training.

The port approach planning unit, received only by the Kings Point groups, required the midshipmen to plan the approach to a representative port. This included the approach, entrance, and transit of a channel for several miles to a point at which ownship would make lee for a pilot.

It should be noted that the functional requirements for a cadet training simulator are strongly dependent on the skills within the cadet training program to be developed on the simulator. These experiments assume that rules of the road skills and port approach planning skills are principal candidates for simulator-based training within the cadet training program.

The experiment/prototype training course, once completed, was then evaluated with regard to:

a. Effectiveness of simulator-based training for cadets on rules of the road and port approaches as determined by means of simulator pretests and posttests.

b. A simulator variable – day versus night training situations. The Kings Point group was divided into two subgroups, A (day) and B (night). The objectives were to compare relative effectiveness of day versus night training by means of simulator pretests and posttests.

c. A training methodology variable – distributed learning versus concentrated learning. The Kings Point group received rules of the road training over a 6-week period while the Fort Schuyler group received the same program in 1 week. Differences in training gain measured by pretest/posttest may indicate differences in concentrated versus distributed learning.

The analysis and interpretation of the results of this experiment with regard to the above mentioned variables, enabled the following conclusions to be drawn:

- Although no collisions were experienced during the experiment, the CPAs achieved with traffic vessels under open sea conditions were less than 1 nm on the average and considered as only marginally acceptable. The instructors felt that substantially larger CPAs should be achieved by 3rd mates on watch in these situations. The achieved CPA represents the culmination of several aspects of man/ship system performance. Several of these contributory aspects of performance that impact the resultant CPA are addressed below.

- Stand-on vessel action under Rule 17 at night was, on the average, taken too early. The cadets appeared to lack confidence at night, with the result that their excessive caution conflicted with the intent of the Rules.

- Vessel handling problems were observed under high wind conditions (40 knots). It appears that this may be due to insufficient understanding of: (1) responsiveness of the vessel to various rudder angles, (2) effect of a high wind on a loaded tanker and/or (3) difficulty in position fixing.

- The available information was not fully utilized in evaluating and responding to problems. The cadets over-emphasized the radar information, while often neglecting visual information. This was probably due to: (1) proficient radar plotting skills after effective radar training courses; and (2) a lower level of visual skill explained by the lack of equivalent practical visual training. One

notable example of the visual skill deficiency is that the cadets did not understand how to use range lights.

- Substantial room for improvement was observed in communication and bridge procedures used by the cadets. Areas for improvement included notification of the master regarding an impending situation, communication of maneuvering orders to the helmsman, bridge management and VHF communications.

- Kings Point and Fort Schuyler cadet groups achieved similar results, but consistent differences were noted in their control actions and bridge procedures. This indicates that some differences in procedures and control actions of more senior personnel may stem, at least in part, from their academy training.

- The simulator training was effective in improving cadet skills, specifically:
  - Rules of the Road perceptive and decisionmaking skills
  - Port Approach shiphandling and navigation skills, especially use of visual bearings and cross-checking multiple navigation sources
  - Overall bridge procedures including helm orders, VHF communications, bridge team organization/communications, and notification of the master

- The day and night Rules of the Road training programs both effectively improved cadet skill in bridge procedures and in handling threat traffic vessels. For the Port Approach segment, however, only the position fixing skills improved under nighttime training. In day training, both position fixing skills and shiphandling skills improved. Additional night training may be needed.

- Having the cadets in simulator training one day a week over six weeks (distributed training) appeared to be more effective than having the identical training concentrated into one week. This conclusion is consistent with research results from other training situations and with the general theories of learning. The difference was not tested rigorously here, however, because there were several other ways in which the relevant groups were different, apart from the training schedules.

- Cadets find ship bridge simulator training in general to be of substantial benefit as a supplement to their at-sea training. Even this initial, experimental training program was considered to be of substantial benefit.

1.4 CADET TRAINING EXPERIMENT – PHASE 3

The Phase 3 cadet experiment described herein is based on the training program developed and investigated during Phase 2 of the CG/MarAd Training and Licensing Project. This experiment, however, examines a different high cost simulator design characteristic, namely horizontal field of view, in place of the day/night visual scene design characteristic examined in Phase 2. Secondly, due to funding and logistical constraints, only cadets from the U.S. Merchant Marine Academy participated in the Phase 3 program.

SECTION 2

METHODOLOGY

2.1 APPROACH

In order to develop objective information upon which the functional specification for a cadet simulator could be based, a series of cadet training experiments were conducted at CAORF. The purpose of these experiments was to investigate a wide range of issues, particularly high cost simulator characteristics, that could not be effectively resolved through subjective analysis. The first cadet training experiment focused primarily on the issues of (a) daylight versus nighttime simulator-based training and (b) concentrated (1-week duration) versus distributed (1-academic-quarter duration) simulator-based training. The issues to be investigated by this experiment, which is the second cadet training experiment, are discussed below in Section 2.3.

It should be noted that the functional requirements for a cadet training simulator are strongly dependent on the skills within the cadet training program to be developed on the simulator. These experiments assume that rules of the road skills and port approach planning skills are principal candidates for simulator-based training within the cadet training program. A more in-depth analysis of the skills required by a proficient 3rd mate and their potential development via simulator-based training is being conducted during Phase 3 of this U.S. Coast Guard/Maritime Administration program.

2.2 CADETS/TRAINEES

Twelve U.S. Merchant Marine Academy cadets/trainees participated in the experiment/training program. To participate in this program, each of the 12 trainees had to be:

- A first class cadet (seniors)
- Representative of the cadet/midshipman population

A demographic description of the students who participated in the Phase 3 program is contained in Appendix J.

The 12 course participants were equally divided into two groups of six. Each group of cadets was then further subdivided into three-man teams. A three-man team stood watch on the bridge during the training exercises on the simulator. The three-man team was comprised of:

- A senior watch officer (SWO)
- A radar observer
- A navigator

The cadets rotated positions within the team after each run.

2.3 EXPERIMENTAL VARIABLE SELECTION

The experimental variable selected for evaluation during this second cadet training experiment was horizontal field of view (F/V). This simulator characteristic is a high cost item; larger fields of view usually require not only additional projectors for the visual scene but also greater computer capabilities as well. The master training experiment yielded very interesting results concerning horizontal field of view. In selected scenarios, students trained with the reduced field of view (120 degrees) actually exhibited significantly greater training gain than those trained with the larger field of view (240 degrees). The rationale behind this unexpected result is very logical. In selected scenarios, the visual cues upon which the student should concentrate and develop his perceptual skills lie directly ahead of the vessel (i.e., ranges). By restricting the field of view, the individual's attention is focused on the pertinent visual cues while other nonrelevant environmental noise is filtered out. While this phenomenon did not occur in all scenarios, it did occur in a scenario that appears similar to the port approach scenario used in the first cadet training experiment.

The specific question to be investigated by the experiment is:

Is a 120-degree horizontal field of view preferable to a 240-degree horizontal field of view for training the port approach planning skills, as the application of the results of the master experiment would indicate?

In the rules of the road training module, which occurs in the open sea, the functional requirements for a simulator's visual scene also become interesting. Since running lights can be seen two points abaft the beam (i.e., 225 degrees F/V), it seems only logical that the simulator should be able to provide visual contact with all vessels encountered in a crossing situation. On the other hand, it can be argued that students can be effectively trained in crossing situations on a 120-degree F/V simulator using (a) visual and radar plotting skills for scenarios, or portions of scenarios, contained within ±60 degrees relative and (b) only radar plotting skills for scenarios, or portions of scenarios, greater than ±60 degrees relative. Of particular concern were crossing situations in which ownship had only a field of view of 120 degrees, causing visual contact not to be made with the traffic ship until relatively late in the encounter (if at all).

The specific question to be investigated by the experiment is:

Is a 240-degree horizontal field of view preferable to a 120-degree horizontal field of view for preparing students to handle crossing situations when the traffic vessel bears greater than ±60 degrees relative?

2.4 SIMULATOR

The experiment/training program was conducted on the CAORF simulator, which is located on the grounds of the U.S. Merchant Marine Academy, Kings Point, New York. The simulator, which is devoted to the conduct of research, has a wide degree of flexibility, making it ideal for this type of research. In addition to a large, high fidelity bridge and visual scene, CAORF has a human factors station at which remote monitoring of the bridge activity and problems can take place as well as extensive data collection and analysis. These analysis capabilities permitted a wide degree of flexibility in configuring the training program. Additionally, the

evaluations of training effectiveness and the other variables will draw heavily upon the quantitative data collected on the computer during each scenario.

Several major subsystems of the CAORF simulator were used during the conduct of cadet training. During the training program:

a. One cadet/trainee team of three individuals was on the bridge and in control of the vessel during each scenario. The two teams comprising each group alternated in service on the bridge.

b. The team not controlling the vessel on the bridge observed the bridge activity and scenario development from the human factors station, except during the pretest/posttest. This was accomplished via a variety of TV monitors with remotely controlled cameras and voice pickups. The instructor participated with this team, discussing the problem as it developed.

c. The data collection and analysis capabilities of the simulator were used to generate, collect, present, and analyze information regarding the experiment/training program.

2.5 EXPERIMENTAL DESIGN

Table 1 summarizes the experimental issues addressed and the approach taken during this cadet training experiment. Two experimental groups, consisting of six Kings Point cadets each, were trained under the treatment condition specified. Their performance before and after training was evaluated for both training modules by (a) written tests and (b) simulator-based tests. It should be noted that for the rules of the road module, each cadet was separately administered a pretest and posttest on the simulator, yielding a sample size of six for each treatment condition. However, in the port approach module, due to simulator time constraints and the nature of the training (port approach planning/team training), each group was divided into two subgroups (i.e., bridge teams) consisting of three students each. Each subgroup was administered a pretest and a posttest on the simulator. As a result, the sample size for each treatment condition was only two. This means that statistical descriptions were made for both the rules of the road module and the port approach module, but statistical inferences were made for only the rules of the road module. Subjective evaluation was conducted for both training modules.

2.6 TESTS

2.6.1 Simulator Tests

The simulator pretests and posttests were the primary means by which actual shiphandling performance could be evaluated. Pretests were given at the start of each unit of training; posttests were administered immediately after each unit of training. Individual trainee pretests and posttests were administered in the rules of the road unit while team tests were administered in the port approach planning unit. The rules of the road simulator pretest and posttest contained in Appendix A, consisted of a crossing situation scenario with ownship as the stand-on vessel. The giveway vessel, which was a high-speed container ship (i.e., 25-knot speed), did not maneuver. Ownship was forced to take action to avoid the collision. Both of these scenarios were constructed to be equivalent. This relatively difficult scenario situation encompassed most of the aspects being trained in the rules of the road unit.

TABLE 1. SUMMARY OF EXPERIMENTAL ISSUES AND APPROACH

Experimental Issue: Is a 240-degree horizontal field of view preferable to a 120 degree horizontal field of view for preparing students to handle crossing situations when the traffic vessel bears greater than ±60 degrees relative?		
Training Unit	Methodology	Treatment Conditions
Rules of the road	Pretest versus posttest • Paper and pencil • Simulator	Group A – 240 degrees Group B – 120 degrees
Experimental Issue: Is a 120-degree horizontal field of view preferable to a 240-degree horizontal field of view for training port approach planning skills as the application of the results of the masters experiment would indicate?		
Training Unit	Methodology	Treatment Conditions
Port approach planning	Pretest versus posttest • Paper and pencil • Simulator	Group A – 240 degrees Group B – 120 degrees

A single port approach situation was investigated in the port approach planning unit; hence, the pretests and posttests involved the same situation. The pretests and posttests represented a situation slightly different from that used during the training program itself. The difference was current velocity. The pretest and posttest had a current of 1.5 knots flood while currents during the training program ranged from 3.0 knots flood to 3.0 knots ebb.

Each cadet in the port approach planning unit took a paper-and-pencil pretest in the form of actually planning the port approach. The teams of three cadets each (senior watch officer, radar observer, and navigator) also developed a port approach plan, after which they actually brought the vessel into the channel. Similarly, the individuals and teams developed the port approach plan on paper immediately preceding their final entrance into the channel with the vessel. Hence, the paper-and-pencil pretests and posttests were closely integrated with the actual performance on the simulator. This method differed from that used in the rules of the road training unit wherein the written pretests and posttests investigated the general area of rules of the road, and a specific scenario situation was performed on the simulator.

2.6.2 Written Tests

2.6.2.1 Rules of the Road. Six written tests were administered during the rules of the road training module. These tests, which are contained in Appendix B, included:

a. Rules of the road (pretest)

b. Radar plotting (pretest)

c. Shiphandling (pretest)

d. Rules of the road (posttest)

e. Radar plotting (posttest)

f. Shiphandling (posttest)

The pretests and posttests are equivalent, but not identical, tests.

2.6.2.2 Port Approach. The written tests for the port approach training module were the individual and group passage plans developed prior to the simulator exercise. These plans were documented on the form contained in Appendix C.

2.7 TRAINING PROGRAM CONTENT

2.7.1 Course Structure

The cadet training experiment commenced during the week of 14 April 1980 and continued for 9 weeks. It was conducted on Tuesday and Thursday afternoons as outlined in Figures 1 and 2.

The first 5 weeks of the cadet training program covered the rules of the road training module. The following 4 weeks covered the port approach planning module. Tables 2 and 3 outline the specific topics covered and the specific scenarios employed during each class meeting for group A and group B, respectively. Appendix A contains a description of each of the training and testing scenarios used.

It should be noted that experimental group B (120 degrees F/V) received classes 6 and 7 prior to classes 4 and 5. The reason for this shift was to allow the same instructor to teach the same crossing situations to both experimental groups. It is hoped that this minimized the instructor effect on the experimental results caused by the use of two instructors.

Each of the 18 class meetings was comprised of three segments: a classroom session, a simulator exercise, and a feedback classroom session. An Instructor's Guide (Appendix D), which specifically outlined the instructional techniques and training aids to be employed during each training session, was developed for the training program. The basic format for the classroom session was:

- Instructor presentation of the class topic and the associated scenarios to be conducted within each simulator exercise.
- Seminar discussion on the proper maneuvering technique for each scenario.
- Positive guidance by the instructor on the proper maneuvering technique for each scenario.

The basic instructional format for the simulator exercise was:

- Brief review by the instructor prior to each scenario.
- Positive guidance by the instructor during the scenario. Since the instructor and nonparticipating students were located in the human factors station, the instructor used the situation display as a training tool.
- Critique by the instructor after each scenario.

A postexercise critique by the instructor was held in the classroom feedback session. During this session, each simulator exercise was reconstructed, using the chalkboard of the visual aid transparencies of each scenario provided, and discussed in detail.

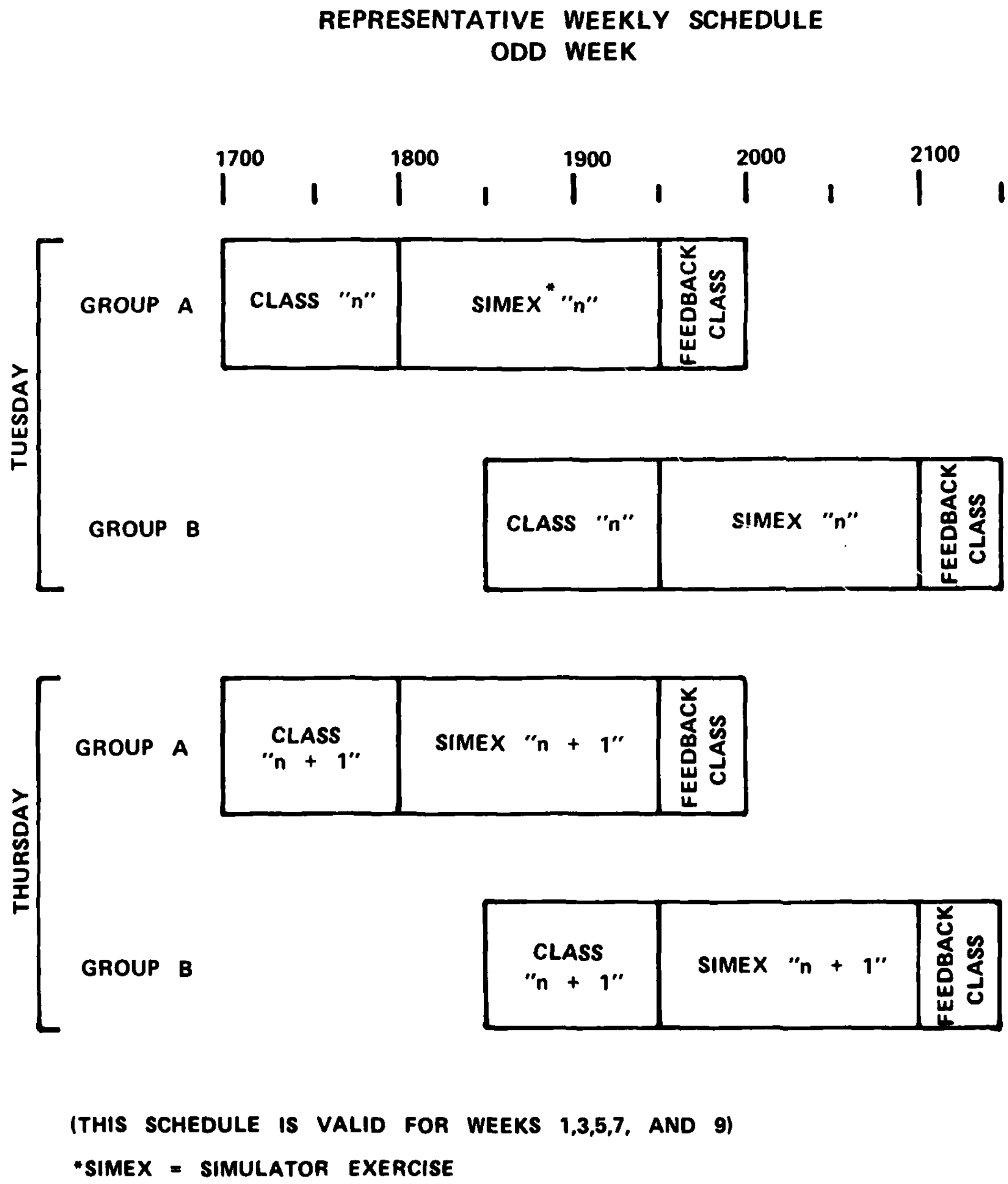
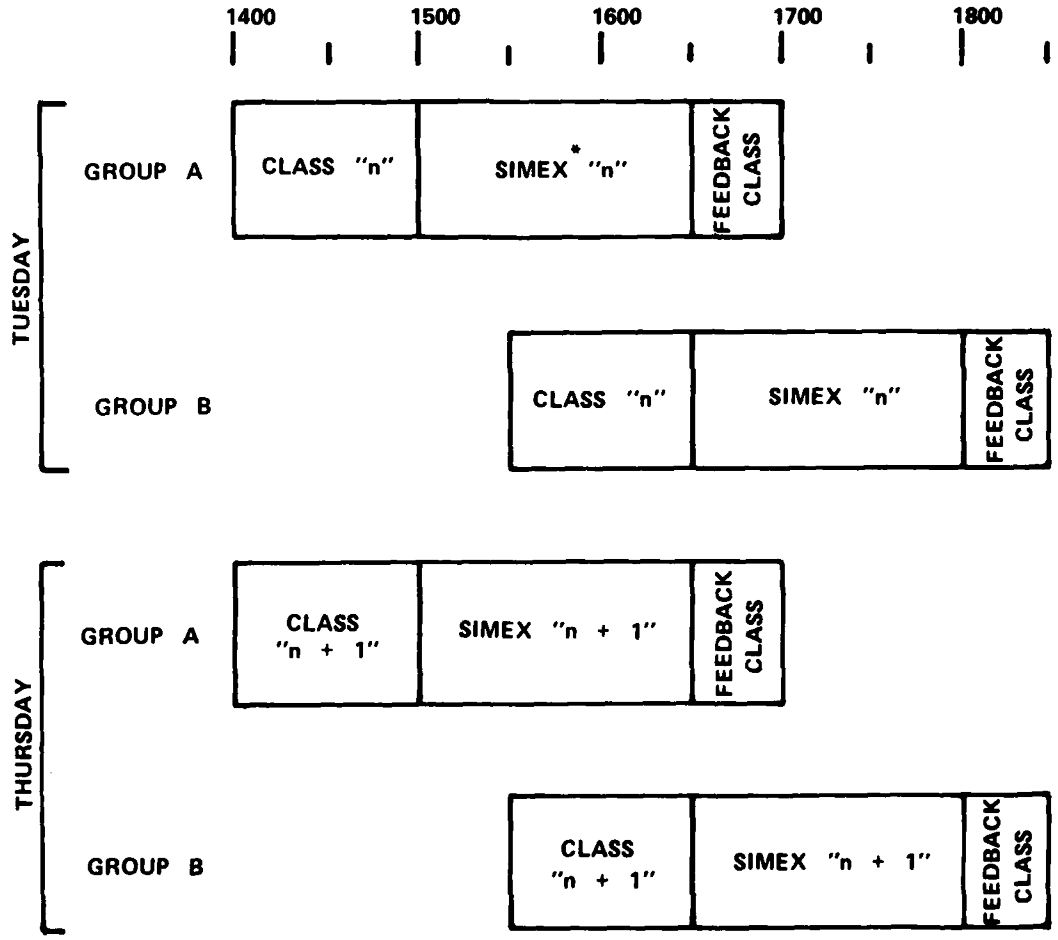


Figure 1. Representative Weekly Schedule – Odd Week

REPRESENTATIVE WEEKLY SCHEDULE
EVEN WEEK



(THIS SCHEDULE VALID FOR WEEKS 2,4,6, AND 8)

*SIMEX = SIMULATOR EXERCISE

Figure 2. Representative Weekly Schedule – Even Week

TABLE 2. COURSE STRUCTURE – GROUP A (240- DEGREE FIELD OF VIEW)

I. RULES-OF-THE-ROAD TRAINING MODULE

Week 1 (14-18 April)	CLASS 1:	Topic-	Introduction	
	SIMEX 1:	Scenarios-	Familiarization	
	CLASS 2:	Topic-	Written Pretests	
	SIMEX 2:	Scenarios-	1,1,1	(Pretest)
Week 2 (21-25 April)	CLASS 3:	Topic-	None	
	SIMEX 3:	Scenarios-	2,2,2	(Pretest)
	CLASS 4:	Topic-	Crossing: Ownship Giveway	
	SIMEX 4:	Scenarios-	9,10,11	
Week 3 (28 April-2 May)	CLASS 5:	Topic-	Crossing: Ownship Giveway	
	SIMEX 5:	Scenarios-	12,13,14	
	CLASS 6:	Topic-	Crossing: Ownship Stand-On	
	SIMEX 6:	Scenarios-	3,4,5	
Week 4 (5-9 May)	CLASS 7:	Topic-	Crossing: Ownship Stand-On	
	SIMEX 7:	Scenarios-	6,7,8	
	CLASS 8:	Topic-	Meeting/Ambiguous	
	SIMEX 8:	Scenarios-	15,16,17,15	
Week 5 (12-16 May)	CLASS 9:	Topic-	Written Posttests	
	SIMEX 9:	Scenarios-	2,2,2	(Posttest)
	CLASS 10:	Topic-	None	
	SIMEX 10:	Scenarios-	1,1,1	(Posttest)

II. PORT APPROACH PLANNING

Week 6 (19-23 May)	CLASS 11:	Topic-	Introduction & Written Pretests	
	SIMEX 11:	Scenarios-	18	(Pretest)
	CLASS 12:	Topic-	None	
	SIMEX 12:	Scenarios-	18	(Pretest)
Week 7 (26-30 May)	CLASS 13:	Topic-	Training Problem #1	
	SIMEX 13:	Scenarios-	19,19	
	CLASS 14:	Topic-	None	
	SIMEX 14:	Scenarios-	20,20	
Week 8 (2-6 June)	CLASS 15:	Topic-	Training Problem #2	
	SIMEX 15:	Scenarios-	21,21	
	CLASS 16:	Topic-	None	
	SIMEX 16:	Scenarios-	22,22	
Week 9 (9-13 June)	CLASS 17:	Topic-	Written Posttests	
	SIMEX 17:	Scenarios-	18	(Posttest)
	CLASS 18:	Topic-	None	
	SIMEX 18:	Scenarios-	18	(Posttest)

TABLE 3. COURSE STRUCTURE – GROUP B (120-DEGREE FIELD OF VIEW)

I. RULES-OF-THE-ROAD TRAINING MODULE

Week 1 (14-18 April)	CLASS 1:	Topic-	Introduction
	SIMEX 1:	Scenarios-	Familiarization
	CLASS 2:	Topic-	Written Pretests
	SIMEX 2:	Scenarios-	1,1,1 (Pretest)
Week 2 (21-25 April)	CLASS 3:	Topic-	None
	SIMEX 3:	Scenarios-	2,2,2 (Pretest)
	CLASS 4:	Topic-	Crossing: Ownship Stand-On
	SIMEX 4:	Scenarios-	3,4,5
Week 3 (28 April-2 May)	CLASS 5:	Topic-	Crossing: Ownship Stand-On
	SIMEX 5:	Scenarios-	6,7,8
	CLASS 6:	Topic-	Crossing: Ownship Giveway
	SIMEX 6:	Scenarios-	9,10,11
Week 4 (5-9 May)	CLASS 7:	Topic-	Crossing: Ownship Giveway
	SIMEX 7:	Scenarios-	12,13,14
	CLASS 8:	Topic-	Meeting/Ambiguous
	SIMEX 8:	Scenarios-	15,16,17,15
Week 5 (12-16 May)	CLASS 9:	Topic-	Written Posttests
	SIMEX 9:	Scenarios-	2,2,2 (Posttest)
	CLASS 10:	Topic-	None
	SIMEX 10:	Scenarios-	1,1,1 (Posttest)

II. PORT APPROACH PLANNING

Week 6 (19-23 May)	CLASS 11:	Topic-	Introduction & Written Pretests
	SIMEX 11:	Scenarios-	18 (Pretest)
	CLASS 12:	Topic-	None
	SIMEX 12:	Scenarios-	18 (Pretest)
Week 7 (26-30 May)	CLASS 13:	Topic-	Training Problem #1
	SIMEX 13:	Scenarios-	19,19
	CLASS 14:	Topic-	None
	SIMEX 14:	Scenarios-	20,20
Week 8 (2-6 June)	CLASS 15:	Topic-	Training Problem #2
	SIMEX 15:	Scenarios-	21,21
	CLASS 16:	Topic-	None
	SIMEX 16:	Scenarios-	22,22
Week 9 (9-13 June)	CLASS 17:	Topic-	Written Posttests
	SIMEX 17:	Scenarios-	18 (Posttest)
	CLASS 18:	Topic-	None
	SIMEX 18:	Scenarios-	18 (Posttest)

2.7.2 Familiarization

The CAORF familiarization session consisted of a 1-hour classroom session followed by a 1.5-hour simulator session. During the classroom session, the students were provided with an introduction to CAORF and briefed on the purpose of the experiment, the goals of training program, and their schedule for the course. They were also provided with student handouts for both the rules of the road training module and the port approach training module (Appendix C). During the simulator session, the students were instructed on the use of the hardware in the pilothouse, introduced to the CAORF visual scene, instructed on how to obtain a "binocular view" (see paragraph 2.7.2.1), and allowed to handle a 80,000 dwt tanker during open-water maneuvers (Figure 3). The principal purpose of this procedure was to acclimate the student to the simulator prior to pretest.

2.7.2.1 Binocular Effects. Some of the experiment runs in the rules of the road module placed ownship in a stand-on situation (or marginal head-on situation) once risk of collision had been determined. It was, therefore, essential for the watch officer to know whether the target ship on his port bow had made a maneuver; as was to be expected, or whether ownship would have to participate to avoid a collision. In a real-life situation, the giveway vessel is normally tracked on radar and/or observed visually with binoculars to determine, as soon as possible, if the target ship had taken its "early and substantial action."

The visual scene at CAORF uses a TV-type raster scan technique, and the resolution is a square of approximately 3/8 by 3/8 inch. If a set of binoculars were to be used by a watch officer to look at a target ship at CAORF, the ship would look larger through the binoculars (i.e., subtend a larger angle at the lee) but would not be resolved any better. In other words, if the target ship consisted of four units of resolution initially, it would still contain four units of resolution through the binoculars although each unit would appear larger to the eye. Therefore, no additional information is obtained by viewing in this manner.

To overcome this difficulty, a closed circuit TV screen set up on the bridge as driven by a remote TV camera viewing a ship model that was manually aligned to conform with the counter situation. The model and camera were located at the control station. The watch officer would call the bow lookout to request a "binocular view" of a ship that he identified by range and relative bearing. The control station operator (bow lookout) would measure the bearing of ownship relative to the target ship on his display and align the ship model accordingly. The view was then presented to the bridge for a port period of time on the TV monitor located on the bridge. The view was not constantly displayed because of the necessity of manually updating the model aspect and it was also felt that a continuous view would be distracting to the bridge watch officer.

2.7.3 Rules of the Road (International)

The training program for this experiment consisted of two training modules: the rules of the road module and the port approach planning module. The rules of the road module addressed vessel handling when in potential collision situations. The three basic ownship situations studied were:

- Crossing situation with ownship as the giveway vessel
- Crossing situation with ownship as the stand-on vessel

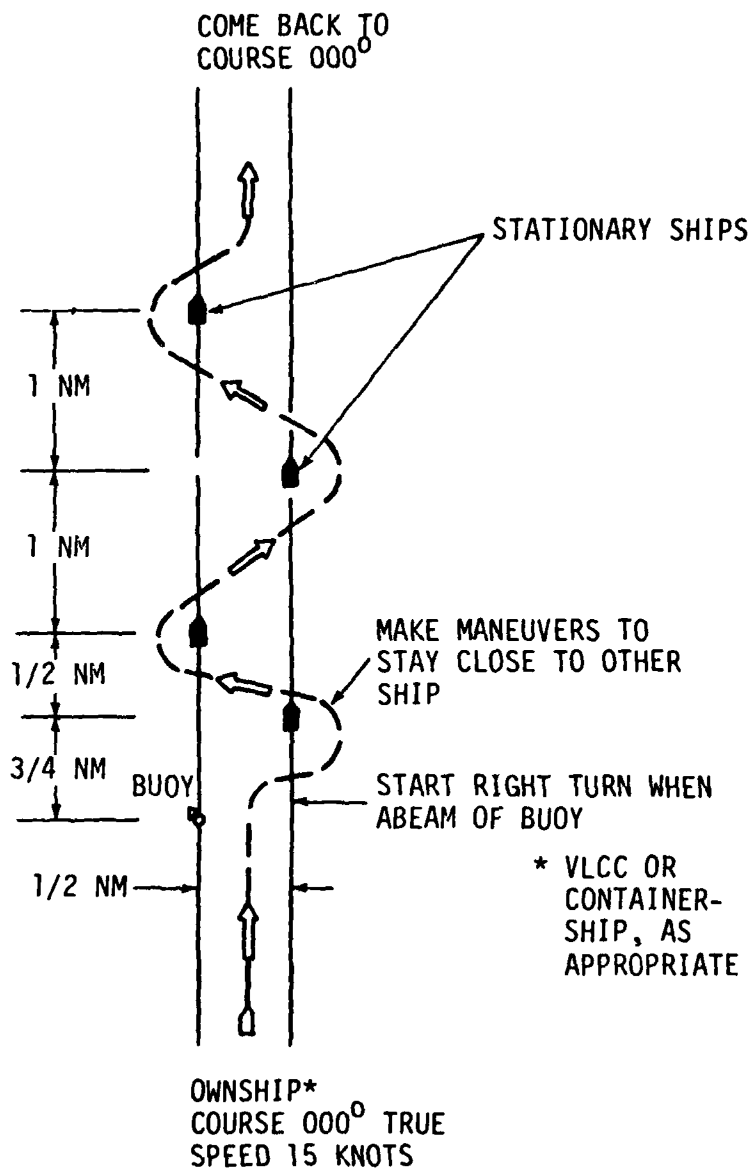


Figure 3. Maneuver Familiarization Diagram

- Meeting/ambiguous situation

The scenarios employed for the rules of the road training module occurred in open water where international rules apply.

The specific issues addressed in this unit were:

- Interpretation of the rules
- Determination of threat vessels
- When to call the master
- When to initiate a maneuver
- Type and amount of maneuver
- Achieved CPA
- Bridge procedures
- Shiphandling characteristics

Table 4 delineates the training objectives to be achieved upon completion of this module.

Performance data were recorded during each scenario. These consisted of: (a) the objective ownship and target parameter information automatically recorded on the computer, (b) observation data collected at the human factors station (see Appendix E for the manual data collection sheets used), and (c) instructor evaluations. An instructor's checkoff list (Figure 4) was used to evaluate the trainees during each run and to provide information for the postrun discussion.

2.7.4 Port Approach Planning

The port approach planning module involved a single representative port approach area. The basic objective was to properly plan and execute an approach, entrance, and channel transit, under various current conditions, to a point where ownship will make lee for a pilot. The students were required to plan every segment of the "voyage," including courses to steer, estimated time of arrival (ETA), effects of wind on vessel, use of aids to navigation, and VHF communications. They were also required to follow appropriate port regulations.

The basic situation in port approach planning was always the same: approach, enter, and transit a channel for several miles to a point at which ownship will make lee for a pilot. The program involved navigating an 80,000 dwt tanker (loaded) into and through a channel (Figure 5), under the following current conditions:

- No current
- 1.5-knot ebb/flood
- 3.0-knot ebb/flood

The pretest and posttest had a 1.5-knot flood current. The various training objectives (see Table 4) were addressed with regard to this situation.

TABLE 4. DETAILED TRAINING OBJECTIVES FOR THE PROTOTYPE CADET TRAINING PROGRAM

Conditions

Good weather with low wind
Excellent visibility
Open sea
Low to high traffic density for rules of the road; low traffic density for port approach planning
Day or night
Ownship is an 80,000 dwt tanker loaded
Closing rates of 20 to 40 knots with the potential collision vessel

RULES OF THE ROAD

1. The cadet will be able to recognize a potential collision situation in sufficient time (i.e., at least 12 minutes) to permit normal ownship actions in response.
2. The cadet will effectively integrate radar and visual information in arriving at a timely assessment of potential for collision (i.e., at least 12 minutes).
3. The cadet will take appropriate action in maneuvering ownship in response to a potential collision situation.
   a. Giveway vessel in crossing situation – maneuver early (i.e., between 5 and 7 nautical miles) and substantially (i.e., 10-degree course change), achieving a closest point of approach (CPA) of at least 1 nautical mile with all vessels.
   b. Meeting situation – maneuver early (5 to 7 nautical miles), achieving a CPA of at least 1 nautical mile with all vessels.
   c. Stand-on vessel in crossing situation – stand-on until it is apparent that giveway vessel is not taking early and substantial action, then maneuver ownship according to rules and avoid the collision.
4. The cadet will be able to plot four target tracks on radar simultaneously, generating estimated CPA information for each to within an accuracy of 3 minutes and 1/4 nautical mile. Furthermore, he will continuously select the four highest priority contacts for plotting.
5. The cadet will understand the relationships between contact range, meeting angle, closing rate, ownship turning characteristics, and desired CPA in determining ownship maneuvers.
6. The cadet will exhibit effective communication and coordination behavior when interacting with other members of the bridge team.
7. The cadet, when acting as senior watch officer, will use appropriate and effective intership communications action (i.e., VHF and whistle).

PORT APPROACH PLANNING

1. The cadet will demonstrate an understanding of ownship turning characteristics.
2. The cadet will demonstrate an understanding of the detailed actions of ownship in entering and transiting a channel and making lee for a pilot.
3. The cadet will plan the detailed actions of ownship (i.e., turn initiation, amount of rudder, speed, ownship track) in approaching and transiting a channel.
4. The cadet will maneuver ownship to enter a channel in the absence of other traffic.
5. The cadet will compensate ownship actions for the effects of current when entering a channel. Current velocity will ary from 0 to 3 knots.
6. The cadet will understand the effect of current on ownship maneuvering (i.e., the effects of current velocity on wnship course and resultant necessary heading change).
7. The cadet will demonstrate effective communication and coordination behavior when interacting with other members of the bridge team.
8. The cadet will use range lights effectively as an aid in entering a channel leg and maintaining appropriate position within the channel.

UNITED STATES MERCHANT MARINE ACADEMY

KINGS POINT, NEW YORK

D460 BRIDGE SHIPHANDLING SIMULATION COURSE

GRADING & CHECKOFF LIST (RATING 0-10)

1. DETERMINATION OF GREATEST THREAT	______
2. DETERMINATION OF RELATIVE MOTION LINE	______
3. COMPLIANCE WITH STANDING & NIGHT ORDERS	______
4. PROPER USE OF VHF COMMUNICATIONS	______
5. CALCULATION OF CPA & SPEED TRIANGLE	______
6. MANEUVERING - TIME AND RANGE	______
6a. MANEUVERING - MAGNITUDE OF RUDDER & SPEED CHANGES	______
7. ACHIEVING OF PLANNED CPA	______
8. RESULT OF MANEUVER	______
9. TEAM COORDINATION	______
10. SENIOR WATCH OFFICER'S COMPOSURE	______
11. PROPER WHEEL COMMANDS	______
12. PROPER COMMANDS TO TEAM	______
TOTAL RATING	______

____

MIDSHIPMAN'S NAME

Figure 4. Instructor's Checkoff List

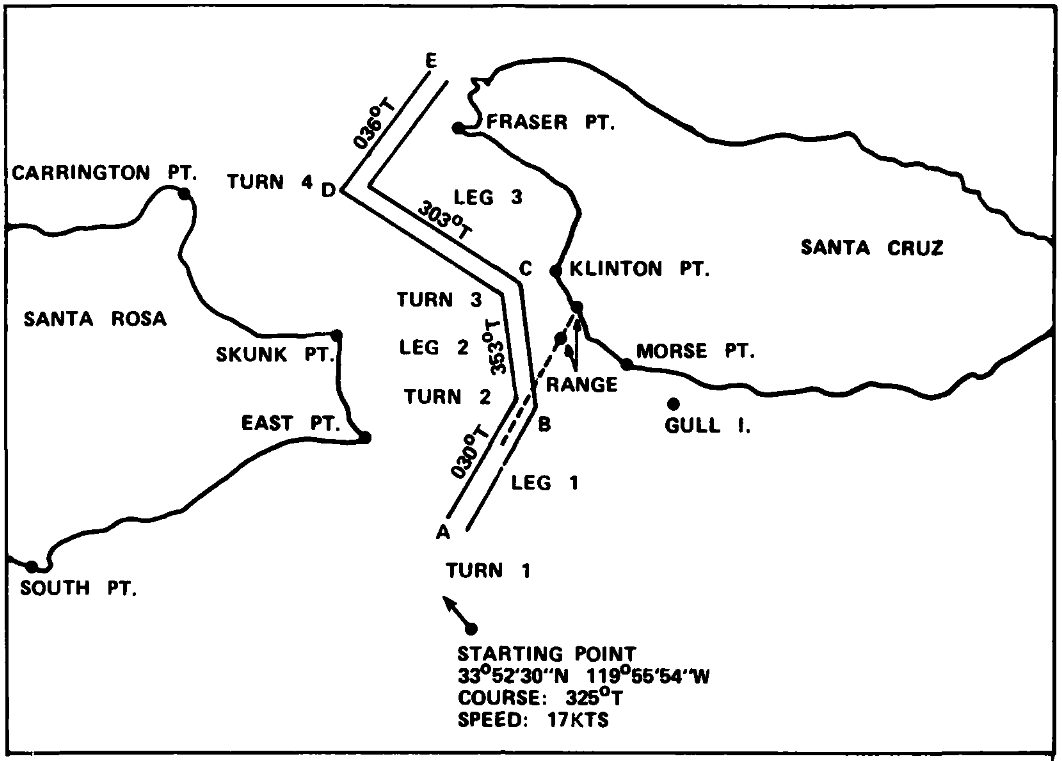


Figure 5. Port Approach Area

The instruction addressed specific issues such as:

- The approach plan
- Any necessary departure from the plan
- Shiphandling (e.g., maneuvering information)
- Current effects
- Bridge procedures

The specific objectives to be achieved upon completion of this module are delineated in Table 4.

The midshipmen were divided into teams of three people each (senior watch officer, radar observer, and navigator) who rotated duties on alternate runs. Each run was videotaped. Critiques of their performance were made using a checkoff list (see Figure 4). Computer generated and observational data (see Appendix E for the manual data collection sheets used) were collected during each run, along with the instructor checkoff lists. The latter were used to provide information for the postrun discussions.

2.7.5 Procedure

Both groups of cadets received both the rules of the road and the port approach units of training. Each group of cadets received identical treatment, with

differences due only to the experimental variables. The procedural steps carried out independently for each group are summarized below:

a. Administer course introduction – classroom overview.

b. Administer CAORF familiarization – 20 minutes in classroom followed by 1 hour on the simulator bridge.

c. Administer simulator pretest for rules of the road – approximately 25 minutes per cadet; each cadet was alone on the bridge.

d. Administer rules of the road training, Unit 1. Approximately 24 hours of training were administered, divided equally between classroom and simulator sessions.

- Each group was subdivided into two teams of three cadets each (senior watch officer, radar observer, and navigator).
- Both teams participated together during the classroom sessions.
- Each team alternated between the simulator bridge and the human factors observation station during the simulator sessions. The team members' functions were to navigate the vessel or to discuss the situation and actions.
- The team operating on the bridge had three specific functions to perform, one by each cadet. They performed as the senior watch officer, the radar observer, and the navigator.

e. Administer simulator posttest for rules of the road – similar to pretest.

f. Administer introduction to port approach planning – unit overview; individual port approach plan development (pretest); team port approach plan development.

g. Administer pretest scenario to cadet bridge teams.

h. Administer port approach plan training, Unit 2. Approximately 18 hours of training were administered, equally divided between classroom and simulator sessions. Group/team functions were similar to those of rules of the road unit. Additionally, each team prepared a detailed port approach plan prior to each simulator run and discussed concurrences, discrepancies, etc., after each run.

i. Administer posttest scenario to cadet bridge teams.

j. All cadets participated in debriefing sessions to discuss aspects of the training program.

k. Data was automatically collected by the simulator during each run. Instructor observations were also recorded. These will form the basis of the subsequent analysis.

2.7.6 Data Analysis

2.7.6.1 General. The first step of the data analysis was to identify the measures to be used in evaluating the cadets' performance on the rules of the road unit and the port approach unit. These performance measures are defined in detail in Sections 2.7.6.2 and 2.7.6.3. Once the performance measures for the two training units were identified, they were tabulated on both the pretest and posttest scenarios, for each cadet (rules of the road unit) and each bridge team (port approach unit).

The cadets' performances on the pretest were used to identify their input characteristics or their proficiency prior to training. The differences between their scores on the pretest and posttest were used to establish the effectiveness of the simulator-based training program for the given experimental treatment conditions. Statistical tests (i.e., t-tests) were used to establish the significance of the observed training effectiveness and to establish the significance of the observations between experimental treatment conditions (e.g., 120-degree F/V training versus 240-degree F/V training).

2.7.6.1.1 T-Test. The probability that the mean of an experimental group differed from the mean of another experimental group merely by sampling error was determined by the t-test. For small sample sizes ($n<30$), it is assumed that the means of the samples are distributed as a "t" distribution with degrees of freedom equal to the combined sample size minus two. The percentiles of the "t" distribution are used to determine the probability of obtaining a ratio of this size merely by sampling error. One must first select an alpha level and then determine the values of "t" are greater than the values in the "t" table (i.e., the probability of obtaining this "t" level by chance). If so, the null hypothesis would be rejected for the particular alpha selected.

2.7.6.2 Performance Measures (Rules of the Road). The following performance measures were used to evaluate cadet performance on the rules of the road test scenarios.

CPA. The closest point of approach between ownship and any traffic vessel, as measured from the "skin" of ownship to the "skin" of the traffic vessel.

Collision. An impact between ownship and any traffic vessel. Measured on a binary scale: yes = collision; no = no collision.

Range of Maneuver. The distance between ownship and the threat traffic vessel when ownship initiates an evasive ship control action (e.g., rudder order, course order, speed change).

Magnitude of Course Change. The difference between ownship's base course, measured in degrees, and the new course ordered as an evasive ship control action to reduce the risk of collision with the threat traffic vessel.

Number of Course Orders. The number of course orders given by the subject navigating the vessel during the entire test scenario.

Number of Rudder Orders. The number of rudder orders given by the subject navigating the vessel during the entire test scenario.

Master Notified. The act of informing the master of the presence of a traffic vessel with whom risk of collision exists based on the criteria set forth in the vessel's standing orders. Measured on a binary scale: yes = master notified; no = master not notified.

Range Master Notified. The distance between ownship and the threat traffic vessel at that instant of time when the master was notified of the existing risk of collision.

VHF Communications. The act of attempting to establish voice radio communications with the threat traffic vessel. Measured on a binary scale: yes = VHF communications attempted; no = no VHF communications attempted.

Range VHF Communications. The distance between ownship and the threat traffic vessel at that instance of time when VHF communications were attempted.

Number of Visual Bearings. The number of visual bearings taken using the azimuth circle to establish risk of collision with the threat traffic vessel during the entire test scenario.

Number of Radar Requests. The number of requests made by the subject who aids navigating the vessel, to the radar observer during the entire test scenario.

2.7.6.3 Performance Measures (Port Approach Planning). The following performance measures were used to evaluate cadet performance on the port approach test scenarios.

Channel Excursion. The act of navigating ownship such that its geographic position exceeds the specified channel boundaries. Measured on a binary scale: yes = channel excursion; no = no channel excursion.

Maximum Track Deviation. The greatest distance between ownship's track and the channel centerline over the entire test scenario. Measured perpendicularly from the channel centerline to ownship's center of gravity.

Mean Track Deviation. The mean distance between ownship track and the channel centerline measured at 30-second time intervals over the entire test scenario. Measured perpendicularly from the channel centerline to ownship's center of gravity.

Number of Track Crossings. The number of times ownship track intersects the channel centerline during the entire test scenario.

Number of Course Orders. The number of course orders given by the subject navigating the vessel during the entire test scenario.

Number of Rudder Orders. The number of rudder orders given by the subject navigating the vessel during the entire test scenario.

Number of Engine Orders. The number of engine orders given by the subject navigating the vessel during the entire test scenario.

VHF Communications. The act of attempting to establish voice radio communications with the vessel traffic service, the pilot station, and the tugs as

appropriate during the test scenario. Measured on a binary scale: yes = VHF communications attempted; no = no VHF communications attempted.

The following are examples of the use of additional performance measures which are related to specific legs and turns.

2.7.6.3.1 Turn 1. The following performance measures were used to evaluate cadet performance during turn 1 of the port approach test scenarios.

Rudder Order Deviation (Planned/Actual). The difference between the rudder angle planned for turn 1 and that actually used. The planned rudder angle is given first, followed by the actual rudder angle. All measurements are expressed in degrees.

Initial Range Offset. The distance from the range line in leg 1 that ownship acquired as a result of its performance in turn 1. Measured perpendicularly from the channel centerline to ownship's center of gravity.

2.7.6.3.2 Leg 1. The following performance measures were used to evaluate cadet performance during leg 1 of the port approach test scenarios.

Course Made Good Deviation (Planned/Actual). The difference between the course made good planned for leg 1 and that actually made good in leg 1. The planned course made good is given first, followed by the actual course made good. All measurements are expressed in degrees.

Course to Steer Deviation (Planned/Actual). The difference between the course to steer planned for leg 1 and that actually used in leg 1. The planned course to steer is given first, followed by the actual course to steer. All measurements are expressed in degrees.

Navigational Plot. The act of maintaining a navigational plot of ownship's position during the test scenario. Measured on a binary scale: yes = navigational plot; no = no navigational plot.

Navigation Fix Error. The mean distance between each geographic position plotted by the cadet navigator on the navigational plot and the vessel's actual position at the same instant in time.

2.7.6.3.3 Turn 2. The following performance measures were used to evaluate cadet performance during turn 2 of the port approach test scenario.

Rudder Order Deviation (Planned/Actual). The difference between the rudder angle planned for turn 2 and that actually used. The planned rudder angle is given first, followed by the actual rudder angle. All measurements are expressed in degrees.

Initial Centerline Offset. The distance from the channel centerline in leg 2 that ownship acquired as a result of its performance in turn 2. Measured perpendicularly from the channel centerline to ownship's center of gravity.

SECTION 3

RESULTS AND DISCUSSION – RULES OF THE ROAD RELATED SKILLS

3.1 GENERAL

The Phase 3 cadet training investigation actually contained two experiments: one experiment dealing with rules of the road related skills and one experiment dealing with port approach related skills. Each of these categories of skills was evaluated, trained, and reevaluated in its corresponding training module. In order to effectively communicate the findings of each experiment, the results and discussion of the rules of the road training module are presented in this section of the report while the results and discussion of the port approach training module are presented in the next section of the report. Section 5 contains the conclusions and recommendations for the entire Phase 3 cadet training experiment.

3.2 INPUT CHARACTERISTICS

Relatively little information is documented about the specific capabilities of graduating maritime academy cadets with regard to their performance on the bridge of a merchant vessel. The Phase 2 cadet training experiment provided some insight into the proficiency level of cadet shiphandling skills (Hammell et al, 1981). The specific conclusions which were drawn from the Phase 2 investigation with regard to rules of the road related skills are discussed in Section 1.3.

The Phase 3 test scenarios differed from the Phase 2 test scenarios in that they were specifically designed to evaluate the effectiveness of training under alternative levels of horizontal field of view. Cadet performance on the pretraining test scenario established cadet proficiency prior to the training. It also provides data on graduating cadet performance for a different test scenario which begins to establish the generalizability of the conclusions drawn during Phase 2.

Since it was necessary to administer the Phase 3 pretraining test scenario over a 2-day period, two equivalent test scenarios were employed (Figures 6 and 7), and the cadets were instructed not to discuss the test scenario that they had received with their counterparts who had not yet taken the test. One-half of the group was administered scenario 1 on the first day while the other half of the group was administered scenario 2 on the second day. Both scenarios involved crossing situations greater than 60 degrees relative between ownship, an 80,000 dwt tanker, and a threat traffic vessel. Ownship was the stand-on vessel while the threat traffic vessel was the giveway vessel. In these scenarios, the giveway vessel fails to maneuver, and ownship must take appropriate action. The geometry of both scenarios is such that a collision will occur at 20 minutes into the scenario. There were two chaff targets in each scenario.

The detailed results of the pretraining test scenarios for the 12 Kings Point cadets evaluated are contained in Appendix F. The following is a discussion of the relevant findings regarding the shiphandling performance of the cadets prior to training (i.e., their entry skill levels).

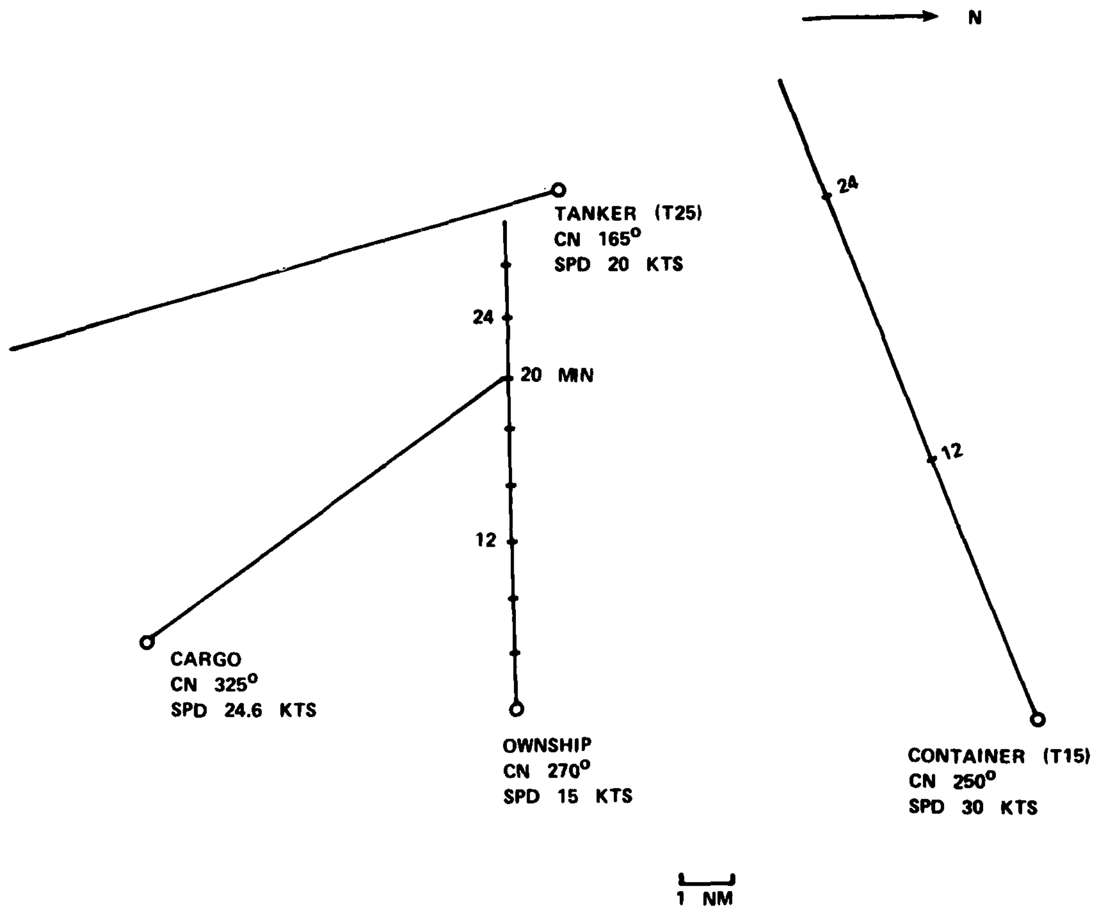


Figure 6. Scenario 1 (Test Scenario)

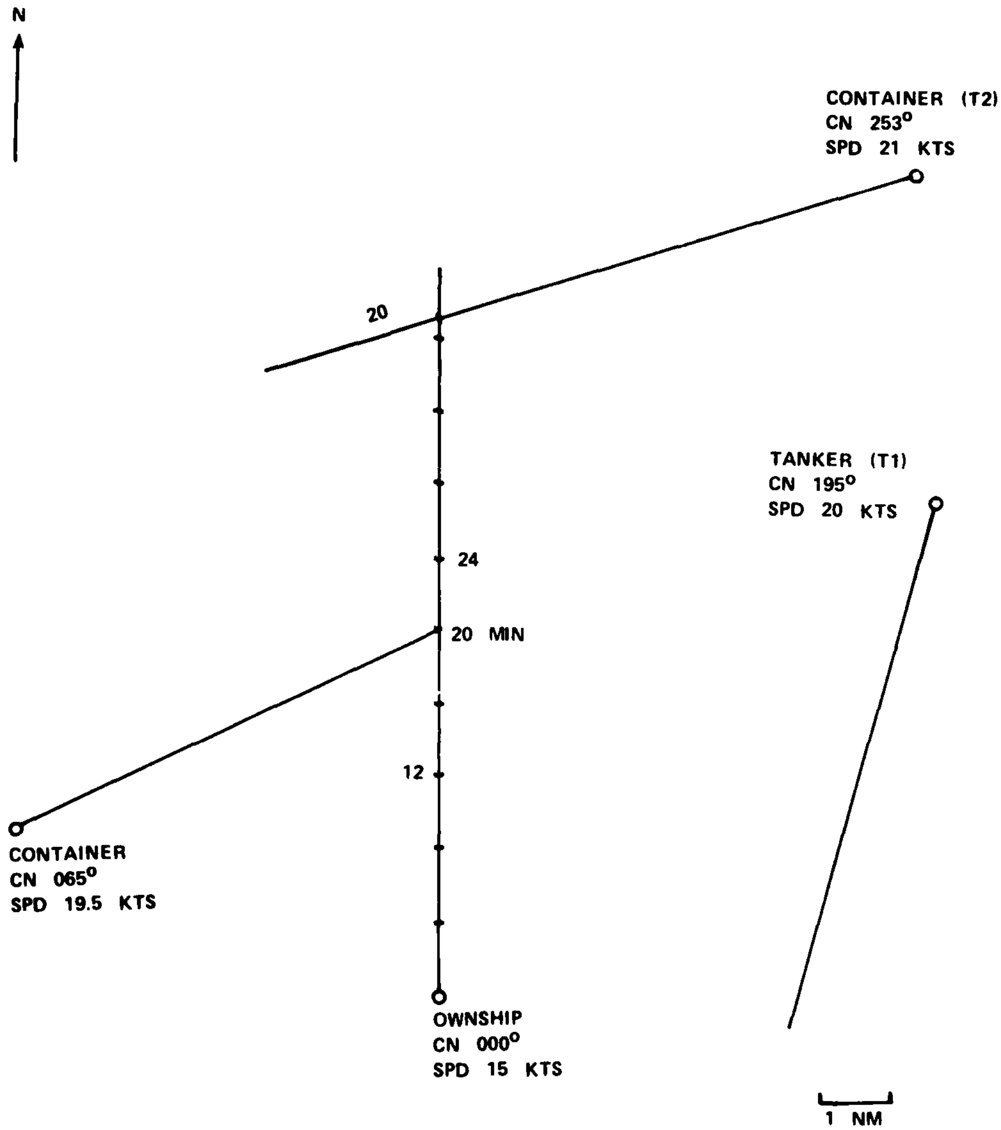


Figure 7. Scenario 2 (Test Scenario)

3.2.1 Stand-on Shiphandling

There were no collisions during the pretraining test scenarios. The mean CPA for the group was 0.88 nautical miles. This CPA is similar to that obtained during the Phase 2 cadet investigation, demonstrating reliable empirical findings. While this CPA was not unacceptable in the situation in which the giveway vessel fails to maneuver, the instructors believed that it should be larger. This analysis of the "bottom line" performance measure (i.e., CPA) is similar with that of the Phase 2 results for the group of Kings Point cadets evaluated under daylight conditions; a larger CPA was wanted.

The CPA obtained was the result of the following control actions initiated by the cadets. First was range of maneuver. The cadets maneuvered at a mean range of 1.83 nautical miles from the threat vessel. This mean range of maneuver appears to be in compliance with Rule 17a (ii) of the International Rules of the Road, which allows ownship to maneuver ". . . as soon as it becomes apparent to her that the vessel required to keep out of the way is not taking appropriate action in compliance with these rules." There appears to be no question that the giveway vessel should have maneuvered prior to 1.83 nautical miles in this scenario. In fact, the giveway vessel should probably be maneuvering at a range of 4 to 5 nautical miles in this particular scenario. It was found during an investigation of the International Rules of the Road (Aranow, Hammell, and Pollack, 1977) that the giveway vessel is expected to maneuver by a range of about 5 or 6 nautical miles. The masters maneuvered the stand-on vessel at an average range of about 4-1/2 nautical miles, in the high speed closing situation investigated. The cadet test scenario had a substantially lower closing rate in a broad crossing situation. The cadets' late maneuver may be due to a variety of factors such as their lack of familiarity with the normal maneuvering ranges of giveway vessels at sea, or it may be due to their giving the giveway vessel complete benefit of doubt, waiting until it is completely obvious that the giveway vessel is not going to take appropriate action. In light of this interpretation, it would appear that the cadets were not taking full advantage of Rule 17a (ii) by maneuvering earlier to reduce the risk of collision. Such conservative behavior would appear to be desirable especially for new 3rd mates.

The second control action initiated by the cadets that influenced CPA was magnitude of maneuver. The mean magnitude of course change was 50.8 degrees. All cadets maneuvered to the right, away from the threat vessel. This action is viewed as acceptable since it was a substantial maneuver. However, it should be noted that after this initial course change, the cadets found themselves on a nearly parallel course with the threat vessel, and many of them had difficulty in getting around the threat vessel to resume base course. The best action for the situation appeared to be a complete "round turn." After the initial maneuver, the majority of cadets attempted various tactics ranging from reducing speed to additional small magnitude course changes with limited success.

The above findings indicate that there is room for improvement in shiphandling skills regarding the stand-on situation. Areas in which improvement would be desirable include the resultant CPA obtained (i.e., a minimum of 1 nautical mile), and the range at which the stand-on vessel maneuver is initiated (i.e., perhaps closer to 4 nautical miles). It should be noted that these input characteristics were not known at the time the training program was developed. Ideally, the training program would be developed after the trainees' input skills are known so as to specifically address those areas that require the most improvement.

3.2.2 Bridge Procedures

The bridge procedures used by the cadets in operating the vessel were deemed to be an important part of their training. Several findings regarding bridge procedures have accrued from the test scenario. First, only 75 percent (i.e., 9 out of 12) of the cadets notified the master of the pending risk of collision even though the CPA was well below the 2-mile standard set forth in the master's standing orders for reporting contacts. Secondly, the mean range at which the master was notified was 3.52 nautical miles. In this particular scenario, this range occurred at approximately 10 minutes prior to CPA. Since the master's standing orders specified that he be notified ". . . not less than 10 minutes from CPA," nearly half of the cadets were late with their report. The format and accuracy of the reports were deemed by the instructors as needing improvement. Third, only 58 percent (i.e., 7 out of 12) of the cadets attempted to contact the threat vessel using VHF communications. Radio telephone procedures also were in need of improvement. Finally, the mean number of visual bearings taken for the pretraining test scenario was 1.25. This was below the minimum number (2) required to establish bearing drift. A similar finding was made with the Kings Point cadets evaluated under daylight conditions during Phase 2. It appears that the cadets would benefit from additional instruction in how to make proper use of the information in the visual scene to assess risk of collision during daylight operations. The Phase 2 report (Hammell et al, 1981) also postulated that this neglect of visual bearings may be the result of the radar simulator-based training course unconsciously encouraging too great a reliance on a single source of navigational information (radar) in rules of the road situations which occur under clear visibility conditions. The proper role of the radar simulator may be as a part-task trainer in support of a full-mission simulator or more intensive at-sea training. These are two possible training media through which the students could acquire the proper balance between visual and radar information sources during daylight operations.

3.3 TRAINING PROGRAM EFFECTIVENESS

The training program administered during Phase 3 was a further development of the successful prototype cadet simulator-based training program administered during Phase 2. A description of the Phase 3 training program is contained in Section 2.7. The effectiveness of the training program was obtained by comparing cadet performance on the posttraining test scenario, with cadet performance on the pretraining test scenario with the difference representing the training gain. It is hoped that this program not only documents some of the benefits to be derived from simulator-based training for cadets, but also serves as a basis for the design of future cadet simulator-based training systems.

The results of the comparison of the pretraining and posttraining test scenarios for the 12 Kings Point cadets evaluated are contained in Appendix F. The following is a discussion of the relevant findings.

3.3.1 Shiphandling

As a result of the Phase 3 simulator-based training program, the 12 Kings Point cadets significantly increased their mean CPA from 0.87 nautical mile to 1.86 nautical miles ($t = 3.27$; $p < 0.005$). (See Figure 8.) The latter CPA was preferable as it represents a reduction in the risk of collision. There were no collisions in either the pretest or the posttest scenarios.

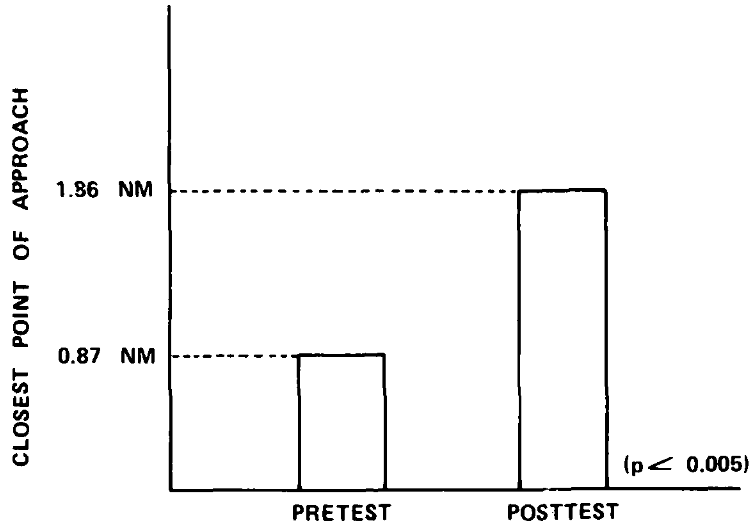


Figure 8. Training Effectiveness — Closest Point of Approach

The Phase 2 cadet training program, as noted earlier, revealed that the cadets achieved a mean CPA of less than desired (e.g., about 0.9 nautical mile when considerably greater than 1 nautical mile would have been more appropriate). A similar finding was obtained in this investigation as noted in the earlier discussion regarding the cadets' input skills prior to training. As a result of the Phase 2 finding, emphasis was placed in the Phase 3 training program on the achievement of a sufficiently large CPA. The effectiveness of this Phase 3 training program in achieving that objective is evident from the results. This finding, furthermore, demonstrates the effectiveness of a training program in achieving the skill and knowledge of trainees regarding specific shiphandling; the issue of how well this training (i.e., improvement in CPA) transfers to operational performance in the at-sea situation remains to be demonstrated. It is expected that transfer of training will be the subject of a later investigation.

The mean range of maneuver also increased significantly from 1.83 nautical miles to 3.32 nautical miles ($t = 2.62$; $p < 0.005$). (See Figure 9.) Since the giveway vessel would probably maneuver at 4 to 5 nautical miles as previously indicated, it is in compliance with Rule 17a (ii) for the stand-on vessel to maneuver at 3.32 nautical miles, given that the giveway vessel does not maneuver. In addition, it would appear that the greater range of maneuver exhibited on the posttest was more desirable behavior for a new 3rd mate since it is a more conservative action.

There was no significant difference between the magnitude of initial course change on the pretest (50.8 degrees) and the posttest (54.4 degrees). Both were acceptable behavior; however, as previously discussed, the cadets had difficulty getting around the threat vessel and resuming base course on the pretest. On the posttest, 10 out of 12 used a "round turn," the most appropriate maneuver, after their initial course change as a means to return to base course. A "round turn" refers to the maneuver by which ownship returns to base course after an initial course change by continually altering its heading in the same direction as the initial

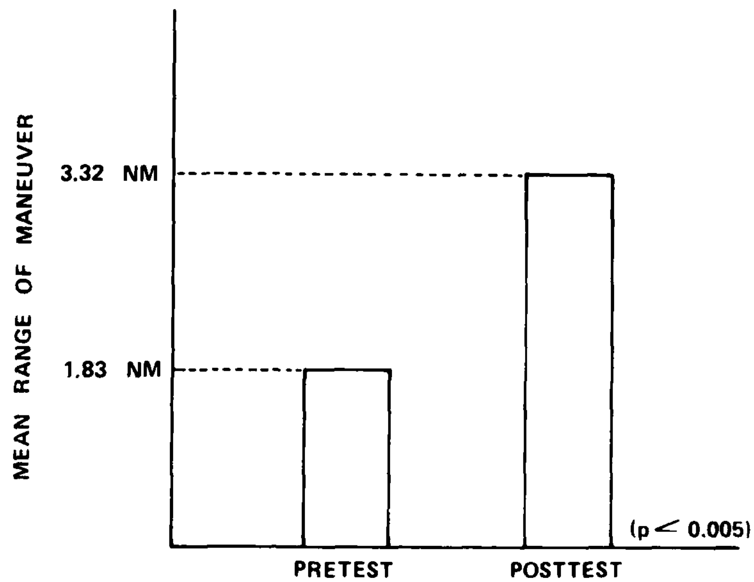


Figure 9. Training Effectiveness — Mean Range of Maneuver

course change until the original course is once again attained. No "round turns" were observed on the pretest. This increase in the proper evasive maneuver from pretest to posttest was statistically significant (Fisher; $p<0.005$) and provides another indication of the type of benefits that may be provided by similar simulator-based training programs.

These results indicate the effectiveness of the rules of the road training module in achieving an improvement in the shiphandling skills of the cadets. The major areas noted for improvement were that of (a) the range at which the maneuver should be initiated and (b) the resultant CPA achieved. Both of these were found to improve dramatically over the course of the training program. The resultant CPA was dramatically improved as a result of a substantial increase at which the stand-on vessel initiated its maneuver. It should be noted that the training emphasis was not to initiate the stand-on vessel maneuver at a particular range, but rather to initiate such a maneuver after it became apparent that the giveway vessel did not take appropriate action. These findings, if they transfer to at-sea performance, represent substantial improvement in the shiphandling skills of the cadet.

3.3.2 Bridge Procedures

The bridge procedures were also observed to improve as a result of the cadet training program. There was 100 percent participation in notification of the master on the posttest – up from 75 percent on the pretest. One hundred percent of the cadets utilized VHF communications on the posttest compared to only 58 percent on the pretest. Furthermore, a substantial improvement in the quality of both types of communications was observed. These improvements in the communication procedures as well as the quality of communications are important in that they have been shown to be related to accidents (Operations Research, Inc., 1978).

The use of visual information improved as a result of training. There were significantly more visual bearings taken on the posttest: 5.91 compared to 1.25 on

the pretest ($t=3.59$; $p<0.005$). (See Figure 10.) There were also significantly fewer radar requests on the posttest: 1.33 compared to 3.33 on the pretest ($t=6.05$; $p<0.0005$). (See Figure 11.) These results are very similar to those observed during the Phase 2 cadet training research for the Kings Point group trained under daytime conditions. They appear to indicate a more appropriate balance after training between the use of two important navigational information sources for the daytime, unlimited visibility scenarios used.

It should also be noted that although radar utilization decreased while visual bearings utilization increased, the combined information gathering activity (as measured by combining radar requests and visual bearings) increased from 4.58 on the pretest to 7.25 on the posttest ($t = 2.99$; $p<0.006$). This increase in information gathering activity may provide an indication that during the training program, not only did the cadets become more aware of the importance of a balance of multiple information sources, but they also came to realize the importance of continually monitoring the situation more closely whenever risk of collision exists.

The Phase 3 cadet training experiment also employed CAORF's "binocular effect" (Phase 2 did not) to simulate the vessel aspect information available to the mate at-sea through his binoculars. A description of the "binocular effect" and its associated procedures is contained in Section 2.7.2.1. The cadets significantly reduced their binocular observations from 3.25 on the pretest to 2.33 on the posttest ($t = 1.55$; $p<0.10$). This may indicate that the trainees learned that visual aspect information was not as valuable as other navigational information (e.g., visual bearings and radar) during the simulator-based training. The reduction may also indicate that the cadets were getting used to a novelty (i.e., the TV screen image of the target model); certainly, the TV image of the target model in place of binoculars is a novelty when first used, although its novel effect likely wears off after repeated use. The instructors believe that the "binocular effect" is not required for teaching rules of the road and could, in fact, become a distraction to emphasizing the proper use of visual bearings, if extreme care is not exercised to limit the range capability of the "binocular effect" as done during this experiment.

The above findings note the effectiveness of the training program with regard to the several bridge procedures investigated. The cadets were deficient on some of these in the pretest (e.g., notification of the master) while not necessarily so in others. The change in communication and use of visual information can be attributed directly to the training program.

3.3.3 Other Findings

The instructors evaluated the cadets' performance on the pretest and on the posttest. This instructor evaluation represents a composite evaluation of the cadets' skills. The instructors' evaluation of cadet performance increased significantly from pretest (65.8) to posttest (105.9) ($t = 12.7$; $p<0.0005$). A copy of the instructor evaluation form is shown in Figure 4.

The cadets' knowledge relating to international rules of the road, radar plotting, and shiphandling also increased significantly as a result of the simulator-based training program (see Appendix F). Their performance on the written rules of the road test increased from 67.6 to 79.7 ($t = 2.67$; $p<0.01$). Their performance on the written radar plotting test also increased from 75.1 to 84.0 ($t = 2.33$; $p<0.025$). Finally, their performance on the written shiphandling test increased from 70.3 to

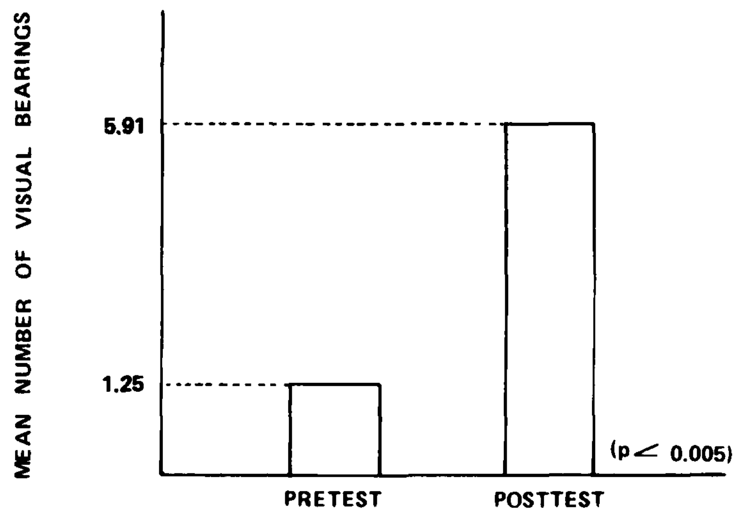


Figure 10. Training Effectiveness — Mean Number of Visual Bearings

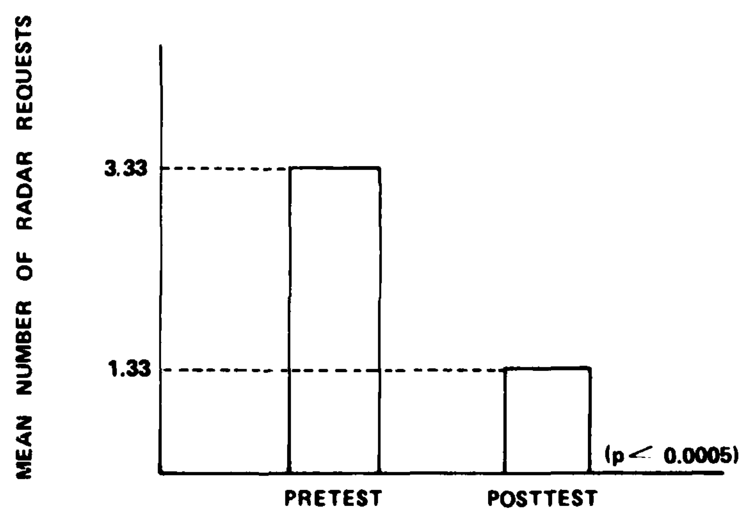


Figure 11. Training Effectiveness — Mean Number of Radar Requests

86.3 ($t = 6.10$; $p<0.0005$). Copies of the written tests used are contained in Appendix B. The substantial increase in knowledge acquired by the cadets over the duration of this simulator-based training program may be due to several factors, including the increase in knowledge gained over the cadets' continuing education at Kings Point during the semester in which the simulator-based training program was administered. It is likely, however, that a substantial proportion of this increase in knowledge is due specifically to the simulator-based training program.

The students' reaction to simulator-based training in general, and to this training program in particular, as a means of training rules of the road related skills was very positive. See Appendix I for a detailed analysis of the student debriefing questionnaire.

3.4 TRAINING UNDER A 120-DEGREE FIELD OF VIEW VERSUS TRAINING UNDER A 240-DEGREE FIELD OF VIEW

The results from the comparisons discussed in this section are contained in Appendix F. When comparing the capability of simulator-based training under 120-degree horizontal field of view and the capability of simulator-based training under 240-degree field of view to prepare the cadets to successfully handle the test scenarios, no significant differences were found in "bottom line" performance measures (e.g., collisions and CPA). Likewise, no significant differences were found in range of maneuver and magnitude of maneuver. Both fields of view were equally successful.

In analyzing bridge procedures, only two significant results were observed. First, as illustrated in Figure 12, the group of cadets trained on the 240-degree field of view took significantly more visual bearings (8.00) than their counterparts trained on the 120-degree field of view (3.83) ($t = 2.04$; $p<0.05$). This may indicate that a tendency could exist to neglect visual bearings at sea for scenarios in which a visual bearing capability was not provided during simulator-based training (i.e., cross scenario greater than ± 60 degrees relative). Second, the number of engine orders issued by the cadets trained under the 120-degree field of view was significantly less (0.0) than those trained under the 240-degree field of view (1.66) ($t = 5.27$; $p<0.01$). This may have occurred because the students who were trained with the 120-degree field of view learned more rapidly than the best way to minimize the amount of time that the threat vessel is in the visual baffle area during the "round turn" is to not reduce speed. Any reduction in speed results in a corresponding increase in the time that threat vessel is out of visual contact.

Finally, it should be noted that the observation of no significant differences for the "bottom line" performance measures (e.g., collisions, CPA, range of maneuver, and magnitude of maneuver) may be related to the geometry of crossing scenarios beyond ± 60 degrees relative. These types of scenarios have inherently slow closing rates. Additional time is, therefore, available to process and verify radar information. As a result, this finding could imply that properly trained radar skills may be sufficient in these slowly developing scenarios. All simulator-based training programs should still instruct that visual bearings are required for such scenarios; however, it appears that the additional cost of a visual horizontal field of view greater than 120 degrees may not be warranted for simulators training solely rules of the road related skills.

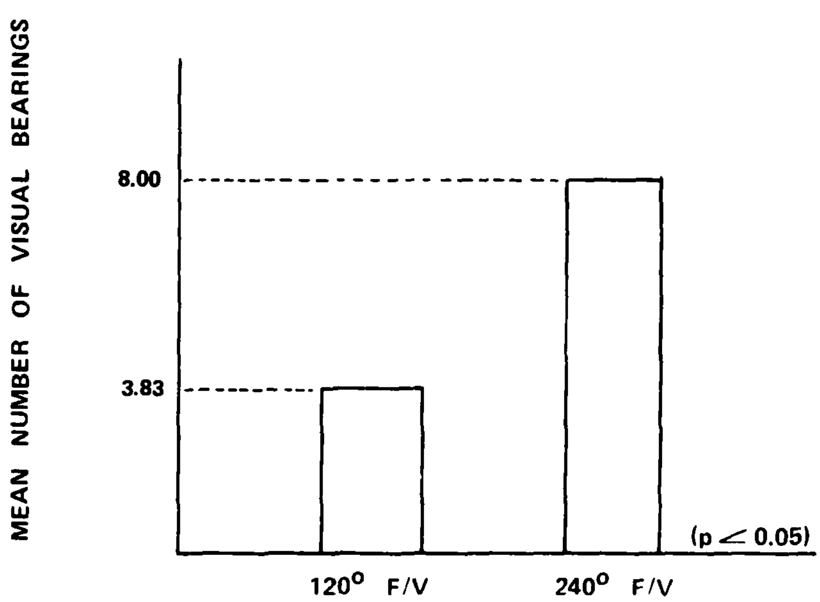


Figure 12. Posttest Comparison — Mean Number of Visual Bearings

SECTION 4

RESULTS AND DISCUSSION – PORT APPROACH RELATED SKILLS

4.1 GENERAL

As previously discussed in Section 3, the Phase 3 cadet training experiment actually contained two experiments: one experiment evaluating the experimental objectives for the rules of the road related skills and another experiment evaluating the experimental objectives for the port approach related skills. This section contains a summary of the results and a discussion of the experiment which relate to the evaluation, training, and re-evaluation of port approach related skills. The detailed results of the port approach planning training module are contained in Appendix G.

In analyzing these results, it should be noted that due to the nature of port approach training as a bridge team exercise, the performance of only four bridge teams was available to describe cadet input characteristics and the effectiveness of the simulator-based training program. Likewise, only two bridge teams were trained either under 120-degree field of view or 240-degree field of view. As a result of these small sample sizes, few statistically significant results can be reported for the port approach training module. However, appropriate trends in the data have been identified, and their impact is discussed herein.

4.2 INPUT CHARACTERISTICS

On the pretraining test scenario, the four bridge teams of Kings Point cadets trained during Phase 3 appeared to have considerably less difficulty in maneuvering the vessel than the two bridge teams of Kings Point cadets trained under daylight conditions during Phase 2. For example, the mean offset after turn 1 for the Phase 3 group was 712.5 feet compared to 1200.0 feet for the Phase 2 group. Likewise, the maximum track deviation in leg 1 for the Phase 3 group was 861.5 feet compared to 1235.0 feet for the Phase 2 group. These observations may be an indication that cadets have less difficulty handling the vessel in a 1.5-knot flood current (Phase 3) than they do in handling the vessel in a 40-knot wind (Phase 2). Caution should be used in applying this interpretation since it may be related to this particular scenario and, therefore, would not be generalizable to other port approach problems.

The ability to the students to determine the position of the vessel during the scenario can be obtained by comparing the vessel's position at a given time on the students' navigation plot to its actual position at the same time on the computer-generated historical track plot for the run. Table 5 contains a listing of the mean navigation fix errors and their standard deviations for the Phase 3 bridge teams in each leg of the pretest scenario. In each of the three legs, the mean navigational error was greater than 900 feet. A navigation error of more than 900 feet (i.e., 300 yards) appears to be undesirable in the 1000-yard channel used during the experiment. This error represents 30 percent of the channel width. It should be noted that Phase 2 bridge teams were able to attain a mean navigation error in leg 1 of 477 feet after training (Hammell et al, 1981). Care should be exercised in interpreting this error since it is not entirely a cross-channel error; much of it is along the channel resulting from labeling fixes with improper times, etc. Such along-channel navigation error may not be critical if the turns are initiated based on

TABLE 5. PORT APPROACH NAVIGATION ACCURACY (PHASE 3)

	Mean Value	Standard Deviation
Leg 1	930.6 feet	41.4 feet
Leg 2	1088.9 feet	362.2 feet
Leg 3	1235.0 feet	593.7 feet

turn bearings, not dead reckoning (DR) times. However, it does appear that cadets require additional training in fixing the position of their vessel in port approach scenarios. A similar observation was made from the results of the Phase 2 research (Hammell et al, 1981).

The VHF communications procedures used by the students in executing their port approach plan could be improved. The four bridge teams' format, accuracy, and management of their communications with vessel traffic control, the pilot station, and the tugs had several deficiencies (i.e., late reports, omitted reports, and inaccurate information). A similar observation was made from the results of the Phase 2 research.

Finally, the division of work and coordination between the members of the bridge team were relatively high. This may be attributable to the fact that the bridge team consisted of cadets who have been classmates for 4 years. They had been through the same traning programs, had a working knowledge of the abilities of the other team members, and were used to working together. These are conditions that will not be found often during their careers in the U.S. Merchant Marine. To know the meaning of proper bridge teamwork and execute it with individuals who have dissimilar backgrounds, ages, education, etc., is quite another issue. Unfortunately, this experimental training program could only address the former – the manning of proper bridge teamwork in a port approach scenario.

4.3 TRAINING EFFECTIVENESS

As a result of the simulator-based training program, the four bridge teams evaluated appear to increase their proficiency from the pretraining test to the posttraining test. Table 6 indicates the success rate of the bridge teams to stay within the boundaries of the channel for each leg of the test scenario. There was a definite improvement in this "bottom line" performance measure in two of the four legs (i.e., leg 2 and leg 3). Also, since 100 percent of the bridge teams navigated leg 1 successfully on the pretest, there was no room for improvement. These indications of training effectiveness are supported by several other performance measures. For example, in leg 1, the mean maximum track deviation was 861.5 feet on the pretest. (See Figure 13.) On the posttest, it improved to 550.0 feet ($t=2.12$; $p<0.05$). In turn 3, the initial centerline offset after completing the turn decreased significantly from 875.0 feet on the pretest to 366.7 feet on the posttest ($t=1.82$; $p<0.10$). (See Figure 14.) The complete results are presented in tabular form in Appendix G. The lack of substantially more significant findings from pretest to posttest appears to reflect the high proficiency of these groups of cadets to safely navigate the test scenario prior to training as discussed in the preceding section.

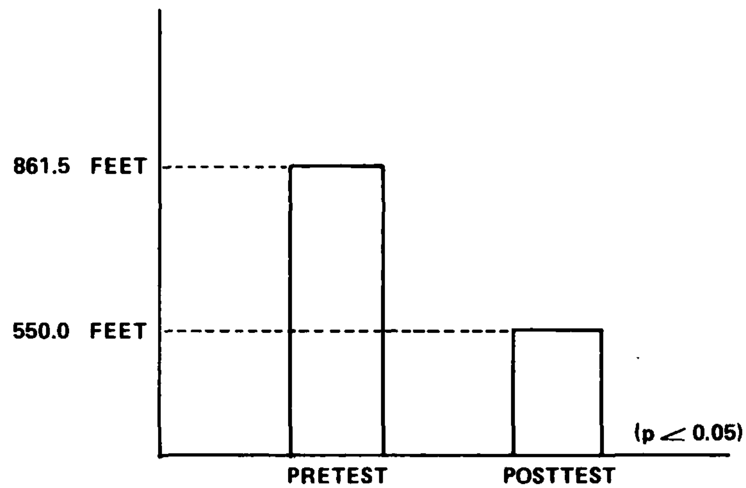


Figure 13. Training Effectiveness – Maximum Track Deviation (Leg 1)

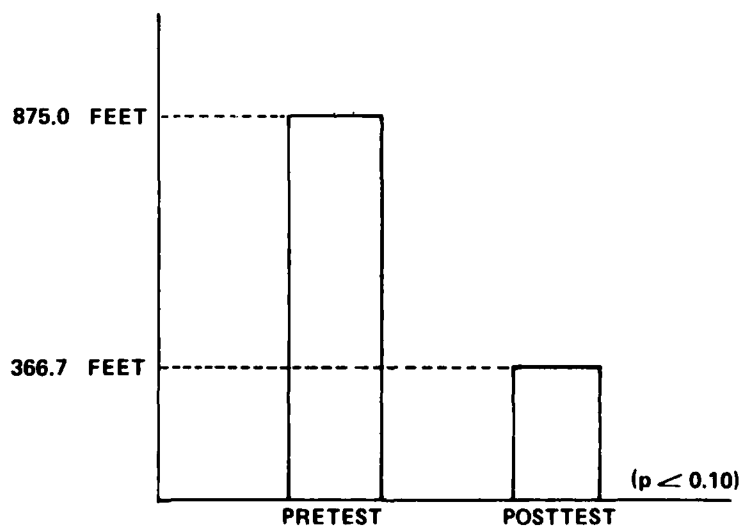


Figure 14. Training Effectiveness – Mean Initial Centerline Offset (Turn 3)

TABLE 6. PORT APPROACH SUCCESS RATE

	Pretest (percent)	Posttest (percent)
Leg 1	100	100
Leg 2	75	100
Leg 3	50	75
Leg 4	50	50

It should also be noted that since the training program was conducted in turn 1, leg 1, turn 2, and leg 2, the difference in cadet bridge team performance from pretest to posttest in turn 3, leg 3, and turn 4 begins to provide an indication as to the generalizability of the training received. The performance of the cadet bridge teams appears to improve in turn 3. As previously cited, the mean initial centerline offset after completing this turn decreased significantly (Figure 14) from 875.0 feet on the pretest to 366.7 feet on the posttest ($t=1.82$; $p<0.10$). No other significant differences were observed for critical performance measures (i.e., maximum distance from channel centerline and initial centerline offset) in these channel segments. From these observations, it would appear that the training received in this particular program may not be highly generalizable to the other scenarios. During this prototype cadet simulator-based training program, only scenarios from one geographic area were used. These would appear to indicate that multiple geographic areas (or multiple segments of one geographic area) should be employed during any training program designed to develop port approach related skills in order to ensure generalizability of the skills developed.

The students' reaction to simulator-based training in general, and this training program in particular, as a means for training port approach related skills was very positive. See Appendix I for a detailed analysis of the student debriefing questionnaire.

4.4 TRAINING UNDER A 120-DEGREE FIELD OF VIEW VERSUS TRAINING UNDER A 240-DEGREE FIELD OF VIEW

Few meaningful differences were observed between the effectiveness of training under the 120-degree field of view and training under the 240-degree field of view. (See Appendix G.) This may be related to the small sample size (two bridge teams per experimental group) required as a result of the necessity of training and evaluating bridge teams during the port approach module in lieu of training and evaluating individuals as in the rules of the road module. The risk associated with this small sample size was recognized during the design of the experiment. It was hoped that the analysis of the data would provide some indication as to which horizontal field of view is preferable for training port approach related skills.

One significant finding, summarized in Table 7, does provide insight into which field of view is preferable. When the accuracy of navigational fixes for the 120-degree field of view training from pretest to posttest was compared, no significant difference was found. However, when the accuracy of navigational fixes for the 240-degree field of view training from pretest to posttest was compared, a significant improvement trend was found ($t=1.14$; $p<0.12$). This finding appears to

TABLE 7. PORT APPROACH NAVIGATION FIX ACCURACY

120-degree Field of View		
Pretest	Posttest	
$\bar{x}$ = 1149.0	$\bar{x}$ = 976.0	
σ = 681.5	σ = 1026.7	z = 0.68; NS
n = 25	n = 25	
240-degree Field of View		
Pretest	Posttest	
$\bar{x}$ = 908.2	$\bar{x}$ = 711.7	
σ = 704.3	σ = 311.0	z = 1.14; $p \leq 0.12$
n = 22	n = 17	

indicate an improvement in position fixing skills for the bridge teams trained under the 240-degree field of view. This may be related to the fact that during training, the 120-degree bridge team was unable to obtain any visual bearings greater than plus or minus 60 degrees relative and hence were unable to improve their visual position-fixing skills. It is well recognized that in order to obtain an accurate visual fix, objects should be selected primarily based on a large angle ($\approx$60 degrees) between their bearings (Maloney, 1978). The reduced field of view does not appear conducive to such training. In addition, the bridge teams trained with the 120-degree field of view were unable to obtain satisfactory visual bearings to be used as critical turn bearings. As a result, the 120-degree bridge team was observed by both the instructors and researchers to rely more heavily on its radar navigation skills. This interpretation is supported by the observation that bridge team number 1 of the 120-degree group failed catastrophically on the posttest based on a "bad" radar fix even though satisfactory objects for a visual fix were available.

The port approach planning findings were based on a limited sample size. Hence, the power of the test to show significant findings when they in fact exist is severely limited. The trend data obtained in this experiment would indicate the need for further investigation using a substantially larger sample size. It is expected that considerable more results regarding field of view would be obtained if the sample size was increased to a minimum of six bridge teams.

From these analyses, it would appear that a 240-degree horizontal field of view is preferable when training port approach related skills, primarily as a result of the inadequacy of the 120-degree field of view to provide suitable training for the development of visual position fixing skills. This conclusion should be validated and its generalizability to other port approach scenarios established by future research.

SECTION 5

CONCLUSIONS

5.1 GENERAL

This cadet training experiment, conducted during Phase 3 of the training and licensing project, was designed to achieve several objectives which were similar to those of the Phase 2 experiment:

- Evaluate the shiphandling related skill level of cadets who have completed their at-sea training and are ready to assume duties of a 3rd mate after successfully completing the written examination.
- Evaluate the effectiveness of a simulator-based prototype training program for improving the skills of a cadet/3rd mate.
- Evaluate the cost effectiveness of alternative simulator characteristics with regard to improving the skills of a cadet/3rd mate.
- Provide a simulator-based training course in shiphandling for cadets.

The following discussion, summary, and conclusions reached herein reflect the integration of the previously presented findings across the two groups trained and the two training modules (i.e., rules of the road and port approach planning). The conclusions are an extrapolation of the experimental findings from the controlled environment of the CAORF experiment to the potential real-world application at future simulator-based training facilities. This was the second known ship bridge simulator-based training course conducted at the cadet level. As a result, it provides additional insight into the proper use of simulators and simulator-based training for cadets, an area which in recent months has come under increased national and international scrutiny as previously discussed.

These conclusions are based on simulator-based training research using 12 cadets from the U.S. Merchant Marine Academy (Kings Point). Statements are made concerning cadet characteristics and cadet training at Kings Point. It should be cautioned that the sample of cadets from Kings Point (i.e., 12 cadets) was small. Hence, the inferences made from these data pertaining to the cadet population as a whole should be viewed cautiously since substantial differences may exist between the samples and the overall population of cadets. Nevertheless, these data do provide additional objective information regarding the skills possessed by graduating cadets/3rd mates and the potential effectiveness of simulator-based training programs. Obviously, this data base should be expanded to provide a more accurate representative view of the cadets, as well as broaden the scope of skills investigated.

5.2 ENTERING 3RD MATE CHARACTERISTICS

Immediately prior to the training program, each cadet participating in the experimental training program undertook a test in which he stood watch alone on the bridge. The data collected from this test represent the skill level of cadets who are nearing graduation and will shortly receive their 3rd mates license. These findings are independent of the training program itself since they were obtained prior to the

conduct of the training program. The input characteristics identified during Phase 3 support many of those characteristics identified during the Phase 2 program.

The overall performance of cadets/entering 3rd mates was found to be acceptable. However, performance regarding specific skills was found to have room for substantial improvement via specific additional training. The potential may exist, therefore, for a simulator-based training program to significantly impact the skill level of entering 3rd mates.

A summary of the findings and conclusions is presented below:

- Although no collisions were experienced during the experiment, the CPAs achieved with traffic vessels under open-sea conditions were less than 1 nautical mile on the average and were considered as only marginally acceptable. The instructors felt that substantially larger CPAs should be achieved by 3rd mates on watch in these situations. The achieved CPA represents the culmination of several aspects of man/ship system performance. Several of these contributory aspects of performance that impact the resultant CPA are addressed below. (Supports Phase 2 conclusion regarding the need for training to increase CPA.)

- The available information was not fully utilized in evaluating and responding to the developing situations. The cadets apparently over-emphasized the radar information while often neglecting the visual information. This may be due to a variety of factors, including (a) heavy emphasis on the radar plotting skills during training, perhaps resulting from a very effective radar training program; (b) underemphasis on visual skills during training; (c) some combination of these factors. (Supports Phase 2 conclusion.)

- Substantial room for improvement was observed in the communication and bridge procedures used by the cadets. Areas for improvement included notification of the master regarding an impending situation, maneuvering orders to the helmsman, and VHF communications. (Supports Phase 2 conclusion.)

It should be noted that this investigation is focusing on the potential areas of training improvement for cadets via the use of the simulator. Hence, the study is not addressing the many areas in which cadet performance was well above the minimally acceptable level; these areas, obviously, would not require improved training.

5.3 TRAINING EFFECTIVENESS

The entering characteristics of the cadets/3rd mates represent their level of skill prior to the simulator-based training program. Ideally, the training program would improve the cadet performance in the areas noted above. However, the entry skill information found during this investigat.. , was not available when the training program was developed for this experiment. Rather, the training program was developed prior to the collection and analysis of the input characteristics; it was developed with regard to the anticipated training needs partially based on the Phase 2 findings. As a result, several of those areas found to warrant improvement were addressed during the training program while others were not directly addressed.

The simulator-based training program was found to be effective in upgrading specific skills at the cadet level. Its success documents the ability of such training to improve cadet and hence new 3rd mate performance on the bridge of a vessel.

The findings presented below pertain to the gains in performance as a specific result of this simulator-based experimental training program. That is, they pertain to the change in cadet/new 3rd mate performance above the entry level as summarized above.

- The training program was found to be effective in improving the following cadet skills:
  - Rules of the road perceptive and decisionmaking skills
  - Port approach navigation skills
  - Overall bridge procedures including helm orders, VHF communications, bridge team organization/communications, and notification of the master

  (Supports Phase 2 conclusion.)

- When training open-water rules of the road related skills, cadets trained with 120-degree horizontal field of view exhibit equivalent proficiency in maneuvering their vessels as compared with cadets trained with 240-degree horizontal field of view. No statistically significant differences were observed between the two groups as regards to resulting CPA.

- There may be a danger that cadets trained in open-water rules of the road situations on a simulator with a 120-degree horizontal field of view, may neglect to utilize visual bearings to assist in determining risk of collision for contacts greater than ±60 degrees relative. (See Section 3.4)

- A horizontal field of view of 120 degrees appears to be unsatisfactory when using a simulator-based training program to develop visual position fixing skills in a port approach scenario. This field of view hampered the development of trainee skills relating to (a) the utilization of visual turn bearings and (b) the selection of objects for visual fixes such that their lines of position intersect at appropriate angles as prescribed by accepted navigational practice. (See Section 4.4)

- There may be a danger that simulator-based training in port approach related skills may not be highly generalizable if it is conducted in a single geographic area. Training port approach skills in only one geographic area may reduce the transferability of such skills to other geographic areas.

- It is the opinion of the cadets that simulator-based training in general, and this program in particular, is of substantial benefit. It was also their opinion that the simulator-based training program provides benefit beyond that of at-sea training. They viewed such training as a supplement to at-sea training. (Supports Phase 2 conclusion.)

- Simulator-based training appears to be an effective supplement to at-sea training for cadets. Several shortcomings which were observed on entering the experimental program were corrected during the simulator-based training, underscoring its effectiveness to supplement the at-sea training program. (Supports Phase 2 conclusion.)

5.4 SUMMARY

This second cadet experiment complemented the first pioneering cadet experiment by (a) providing a simulator-based training program to an additional set of maritime academy cadets, (b) objectively assessing the shiphandling skill of a second experiment group of graduating cadets/entering 3rd mates, and (c) providing additional information as to the benefits associated with an effective simulator-based training program for addressing rules of the road and port approach planning. The potential for effective cadet training on the simulator is evident in this investigation, as it was evident in the first cadet training investigation.

SECTION 6

RECOMMENDATIONS

6.1 GENERAL

This investigation represents the second thrust into a new application for the ship bridge/shiphandling simulator. The impact of these findings along with the findings of the first cadet experiment is still broad in scope, affecting many aspects of cadet/3rd mate behavior and the role of the simulator in achieving improved training cost effectiveness. To this point, the wide variety of issues raised regarding cadet training and the use of simulators have been addressed only at the cursory level. Future investigation is required to adequately define behavior and skills required of the cadets/entering 3rd mates, and to determine the cost effective role of the simulator as integrated with the academy curriculum. Many issues must be more fully investigated based on a large sample of academy cadets, to provide an appropriately valid picture of the role of the simulator.

The cadet training program should be expanded so as to provide meaningful training to a substantial segment of the cadet population. The two cadet experiments only addressed a very small number of cadets having, at best, only minor impact on the cadet population. Since this training program (used for both the first and second cadet experiments) has been shown to be effective, it should be expanded to not only provide experimental data but also have a substantial impact on the training of a larger segment of the cadet class.

Careful attention should be given to the design characteristics of the simulator, based on the information developed during this investigation. Relevant information has been developed to be used as a starting point in the design of a simulator for the training of cadets. Considerable additional information is required to fully address the issue.

Specific recommendations are made below.

6.2 CONTINUATION OF CADET TRAINING RESEARCH

The experimental simulator-based cadet training program should be continued to further and more fully investigate important issues arising from the current study. Many of these issues are central to the cost effectiveness of simulator-based training for maritime academy cadets. The wide variety of such potential recommendations are beyond the scope of this report. The more important recommendations are presented below:

1. Investigate the extent of the 3rd mate shortcomings identified in this report. Are the proficiency levels identified for Kings Point cadets also representative of the proficiency levels of graduates of the other maritime academies? Administer and analyze the same pretraining test scenarios to a larger sample of cadets to determine the extent of the problem areas identified in this study?

2. It is postulated that any deficiencies presently observed in new 3rd mate performance are being corrected during the mate's initial break-in period on his first vessel. Administer the same test scenarios to 3rd mates with varying amounts of seatime in order to establish the time required for such postgraduate OJT. The

information would also be useful in providing a more objective basis for addressing the "at-sea equivalence issue."

3. Request that the radar simulator-based training schools stress the importance of multiple navigational information sources (i.e., visual bearings in addition to radar) in determining risk of collision. In the longer term, investigate the use of a full-mission simulator upon an individual's completion of the radar simulator course to ensure the proper balance between the use of radar information and other navigation information sources.

4. Expand the simulator-based training program at Kings Point as a prototype training program. This training course was most successful, but it was of limited scope. If it were expanded to encompass more students and additional simulator-based courses (e.g., emergency shiphandling), greater insight could be gained into the problems associated with implementing a simulator-based training program at the maritime academy level.

6.3 SIMULATOR DESIGN CHARACTERISTICS

This investigation was set up to look at only one simulator design characteristic, a 240-degree field of view versus a 120-degree field of view. In addition, information was collected on other aspects of simulator design as a byproduct of the overall investigation. Several recommendations, which are relevant to simulator design and the development of training system acceptance criteria, can be made in this regard:

1. The design of future simulators for training open-sea rules of the road related skills should have a horizontal field of view depicting the visual details required in any appropriate scenario. If a simulator with a 120-degree field of view is employed, there may be a danger that the trainees will neglect taking visual bearings at sea to assist in establishing risk of collision when contacts have a relative bearing of greater than ±60 degrees relative. The training program should attempt to compensate for this potential shortcoming by emphasizing the importance of taking visual bearings for contacts greater than ±60 degrees relative.

2. A "binocular effect" similar to that employed during this experiment is recommended for simulator-based open-water rules of the road training, but should not be required. If such a "binocular effect" is utilized, it should be carefully implemented to limit its capability (e.g., resolution, range) in order to train the students to utilize binoculars only as a secondary source of navigation information when evaluating risk of collision.

3. The design of future simulators for training port approach related skills should have a horizontal field of view substantially larger than 120 degrees in order to ensure the capability of properly developing visual position fixing skills.

4. Since the ability to use proper VHF communications procedures is one skill in which this research revealed near 3rd mates to be deficient and which was readily improved by the simulator-based training program, the design of future simulators for cadet training should have a simulated VHF communications capability. (Supports Phase 2 recommendation.)

5. Since the ability to properly notify the master of a threat vessel was another deficient skill, the design of future simulators for cadet training should include a

remote observation station for the instructor, such that he can simulate at-sea mate-master communications (e.g., when the master is in his cabin). The remote observation station also provided an excellent point from which the instructor could provide an evaluative commentary to those students not involved in the exercise. In addition, it provided the instructors with the opportunity to use the student pretest as a diagnostic scenario, discussing among themselves points to be emphasized during the training program. (Supports Phase 2 recommendation.)

6. Since this research identified that cadets have a tendency to neglect visual bearings as a means of determining risk of collision, the design of future simulators for cadet training should have the capability for taking visual bearings. In addition, the training program should stress the prudent procedure of utilizing multiple navigational information sources. (Supports Phase 2 recommendation.)

6.4 SUMMARY

The variety of recommendations made above attest to the breadth of impact that this investigation has. The recommendations are based on the cursory nature of this second investigation, in that the training program/investigation generated a substantial amount of additional information regarding cadet/entering 3rd mate skills and the effectiveness of simulator-based training programs for cadets. This investigative effort should continue and expand to generate specific information to assist the evaluation and possible implementation of simulator-based training programs for cadets.

APPENDIX A

TRAINING AND TESTING SCENARIOS

SCENARIOS 1 THRU 7 – ROR APPROACH
SCENARIOS 18 THRU 22 – PORT APPROACH MODULE

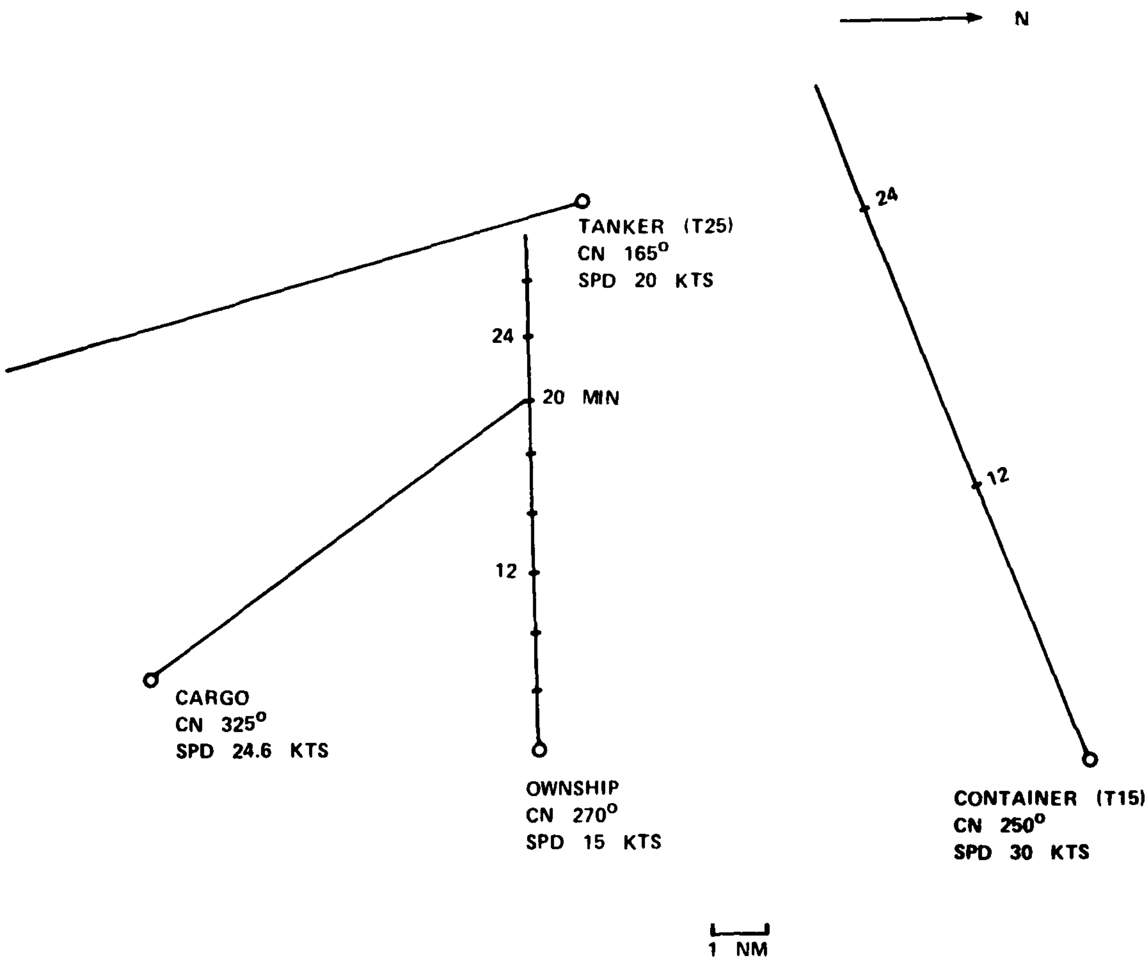


Figure A-1. Scenario 1 (Test Scenario)

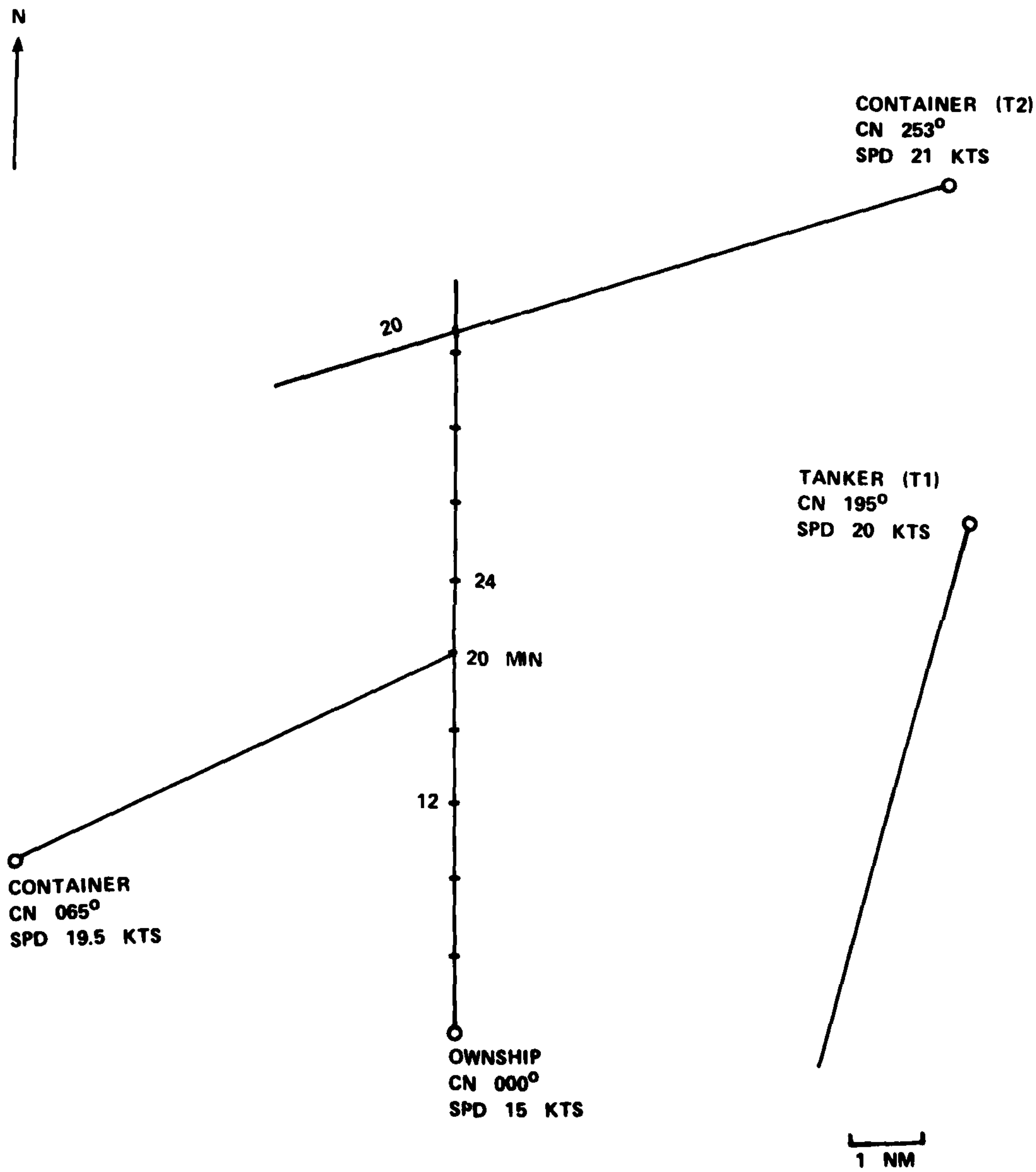


Figure A-2. Scenario 2 (Test Scenario)

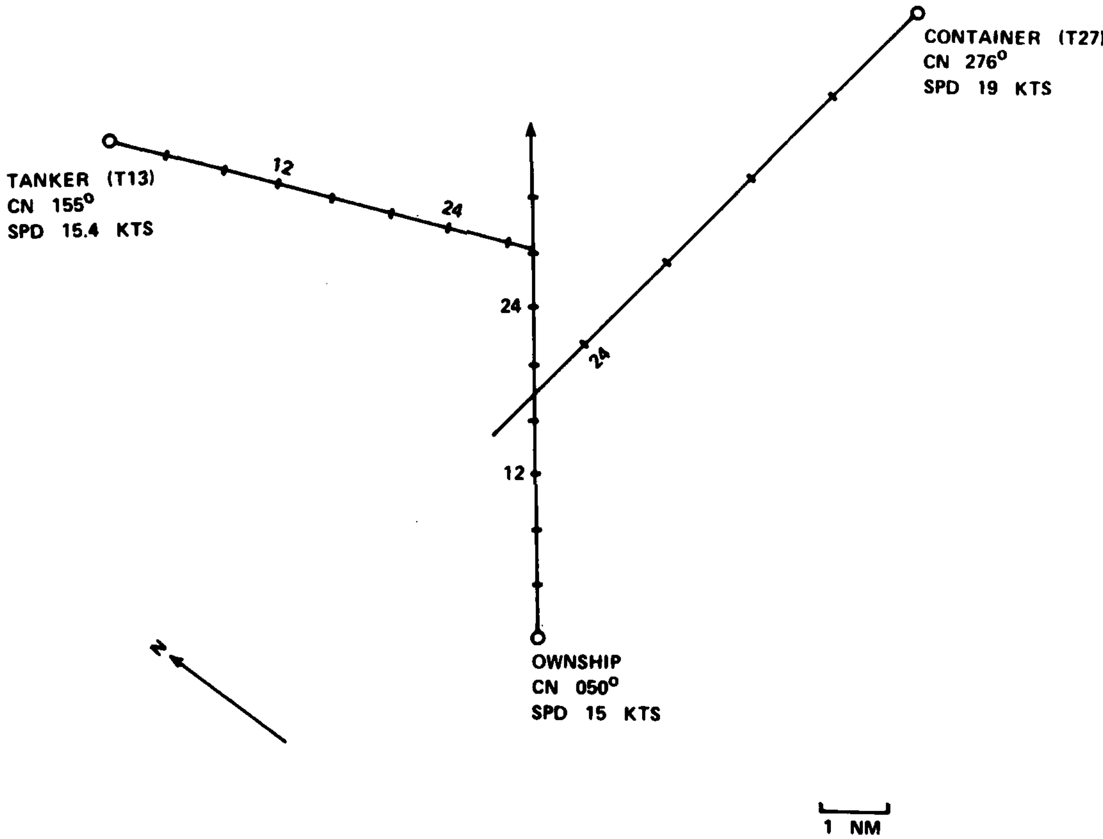


Figure A-3. Scenario 3

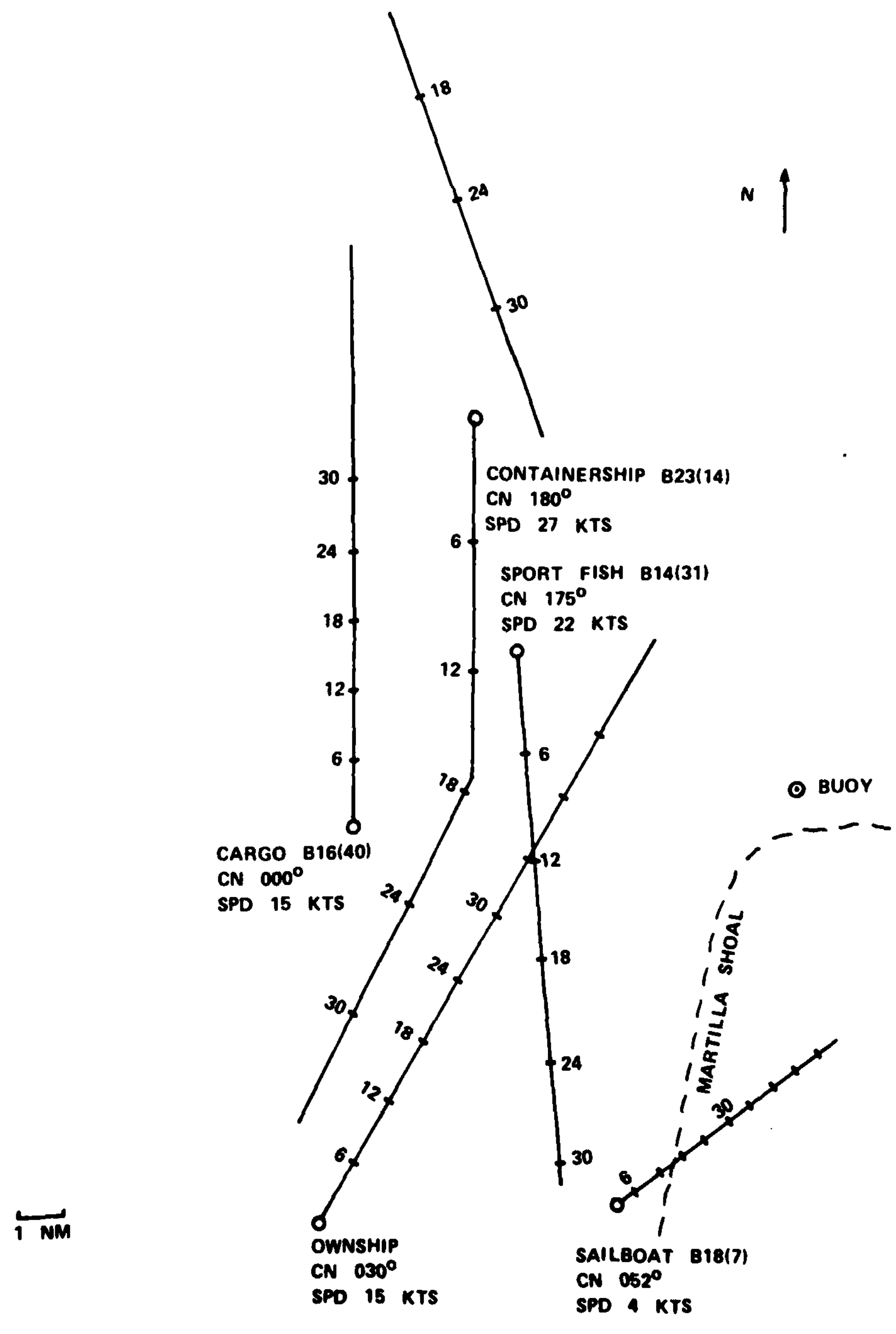


Figure A-4. Scenario 4

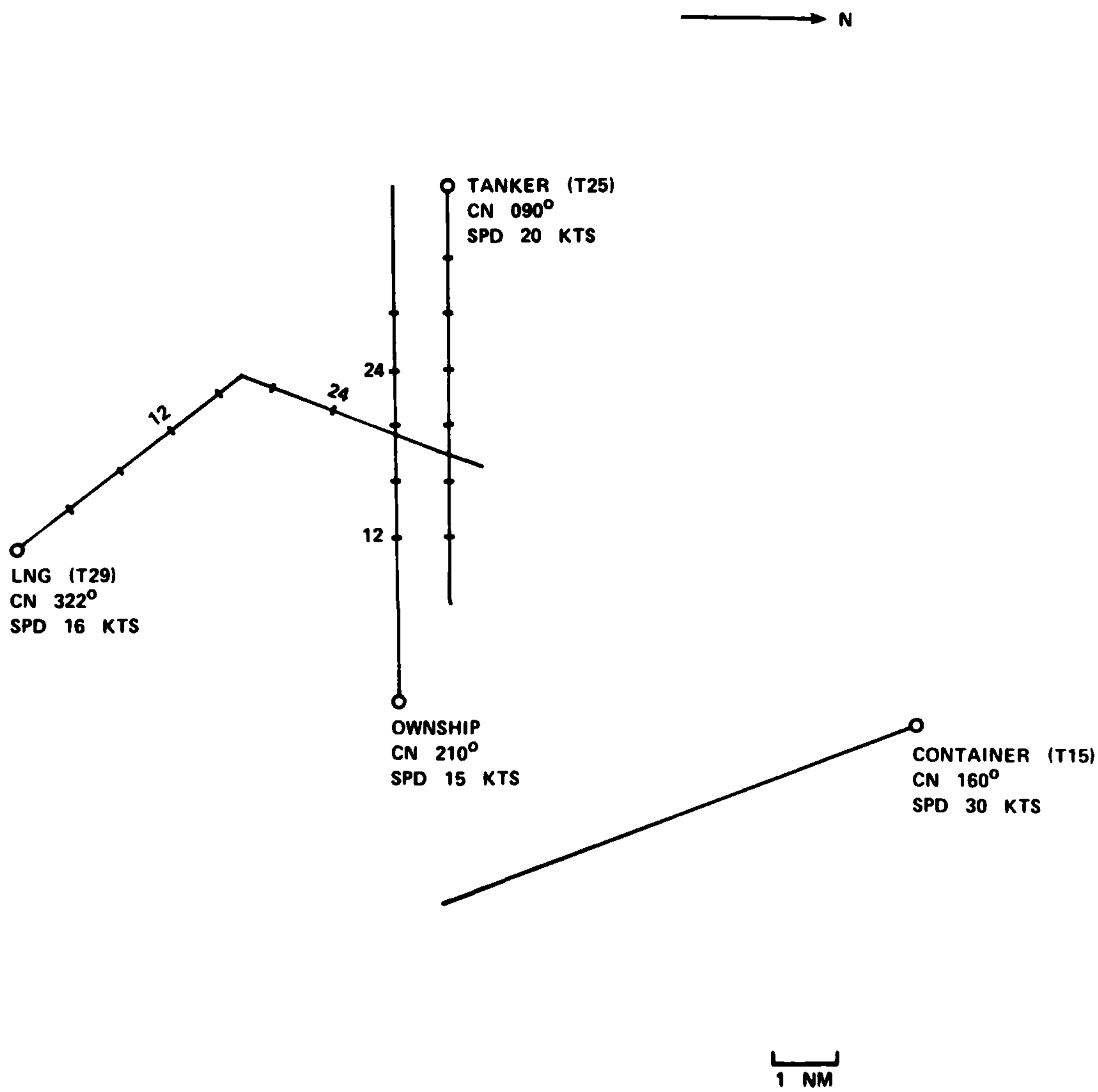


Figure A-5. Scenario 5

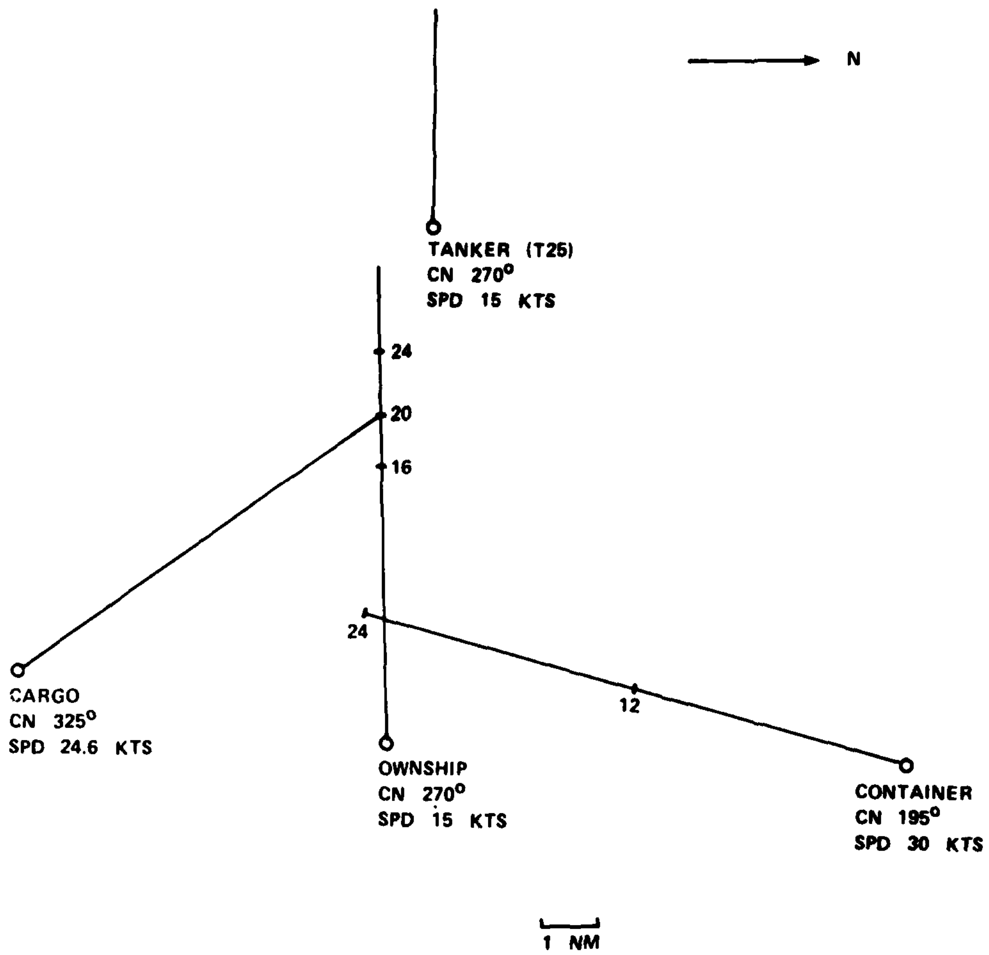


Figure A-6. Scenario 6

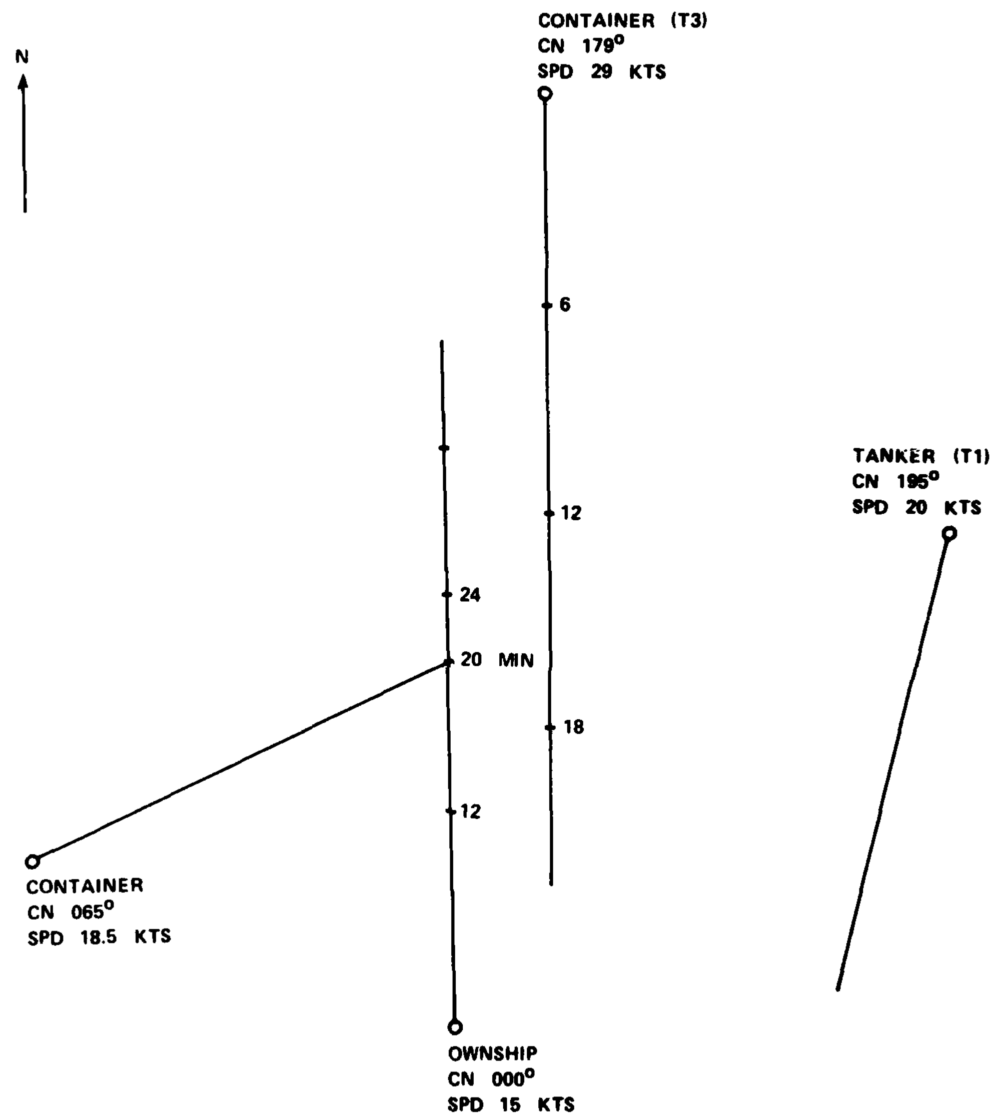


Figure A-7. Scenario 7

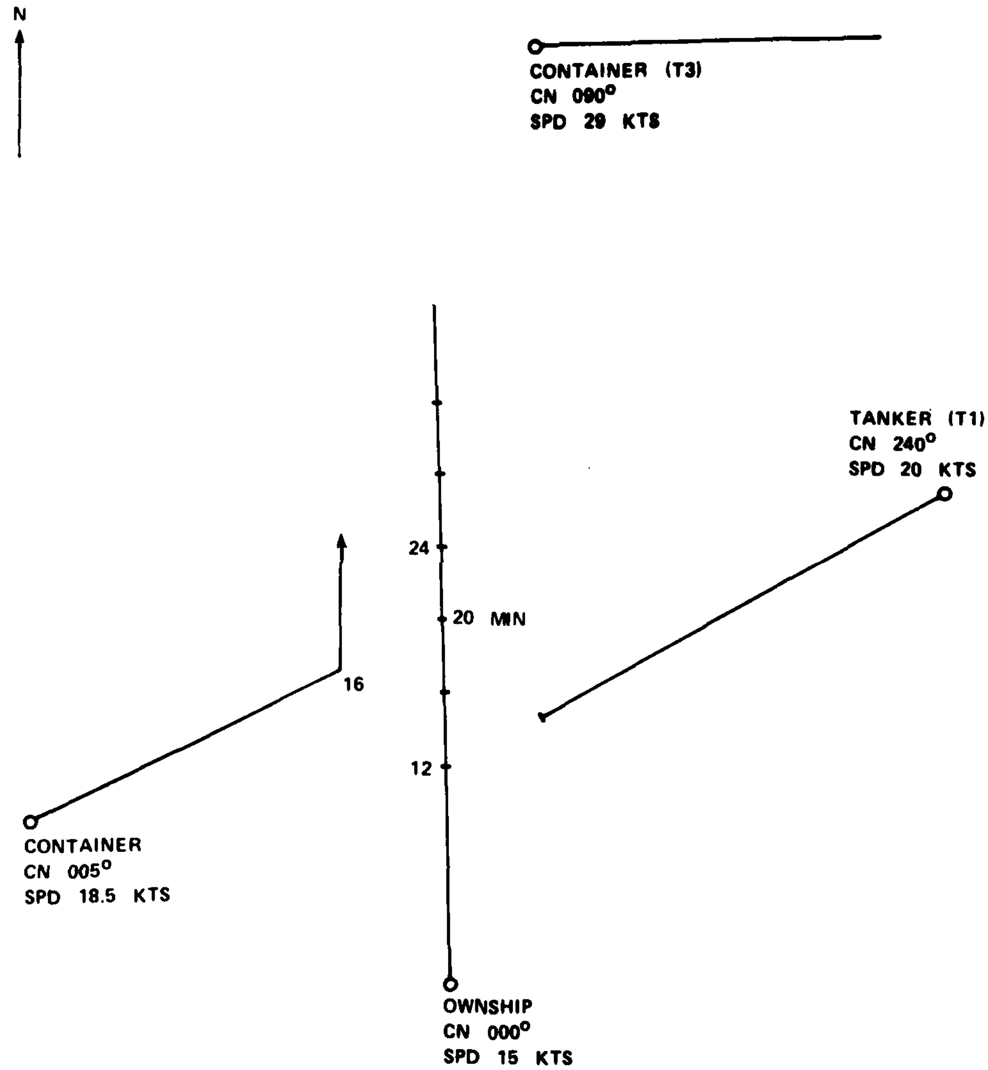


Figure A-8. Scenario 8

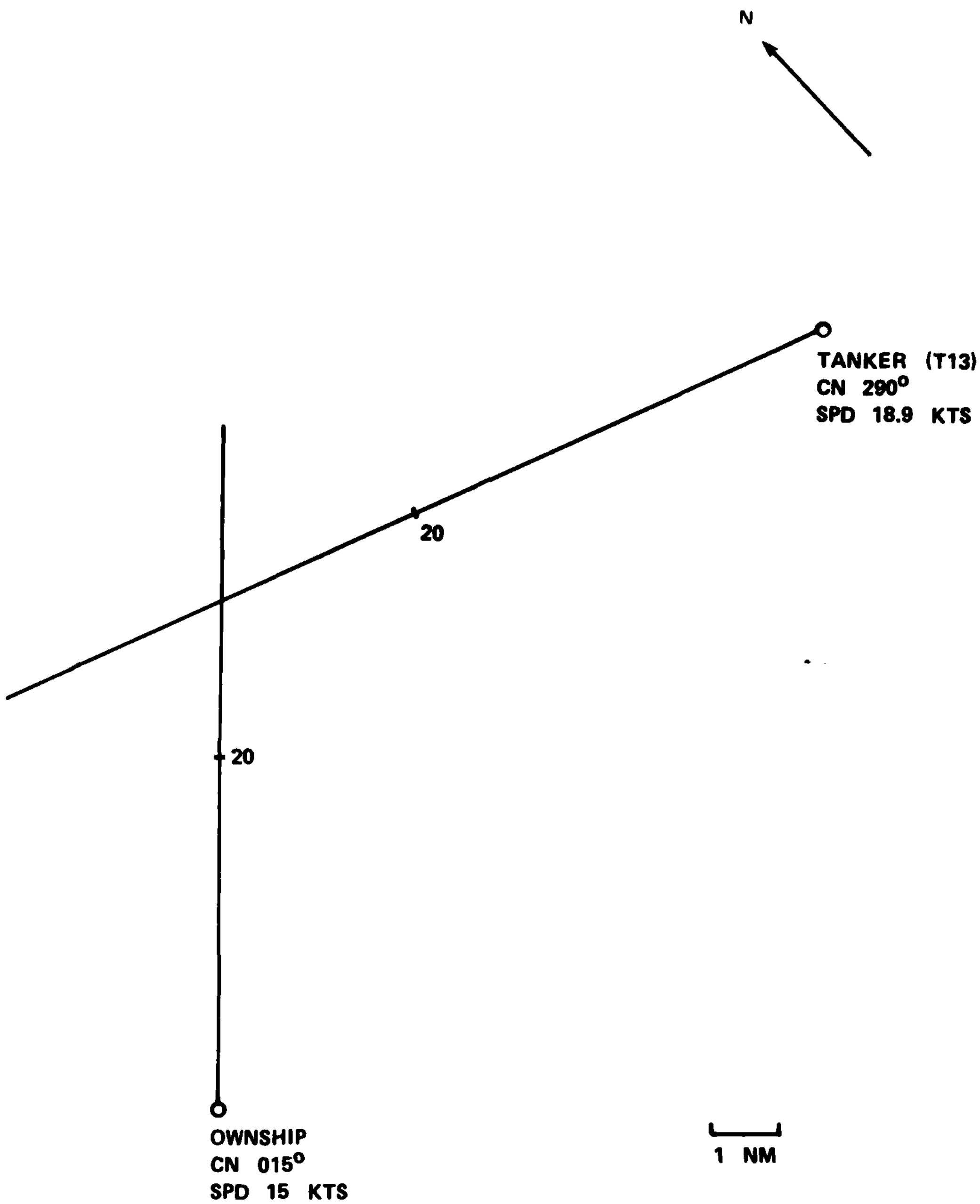


Figure A-9. Scenario 9

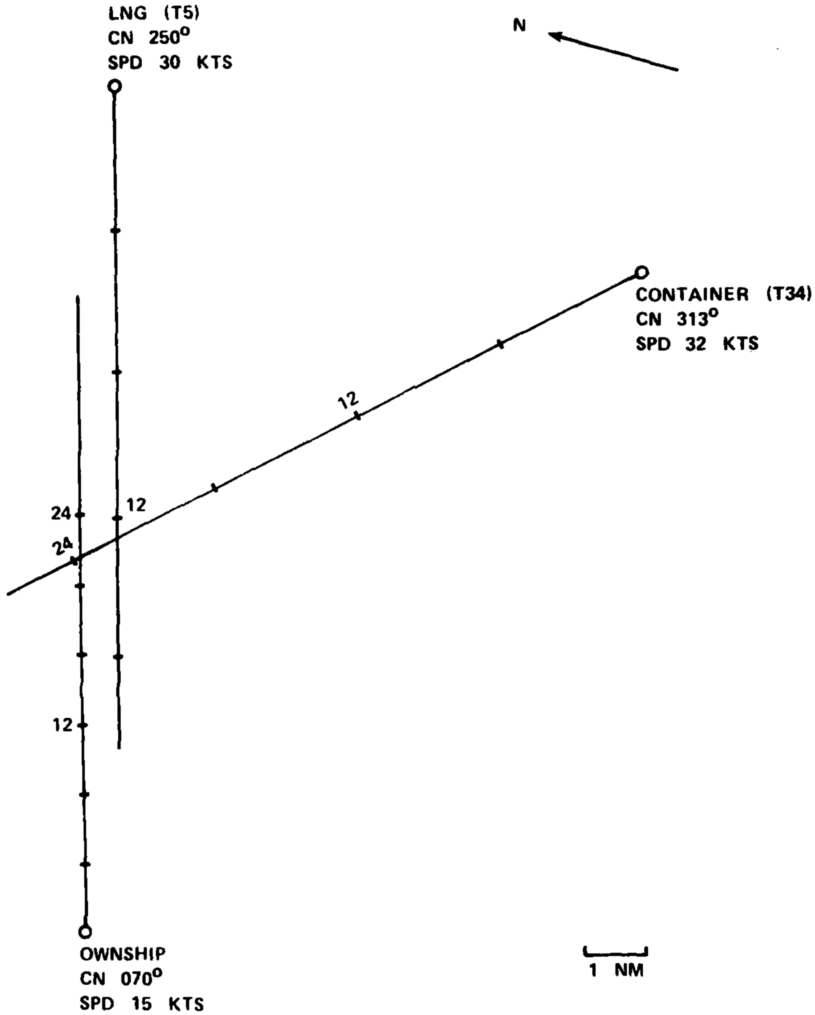


Figure A-10. Scenario 10

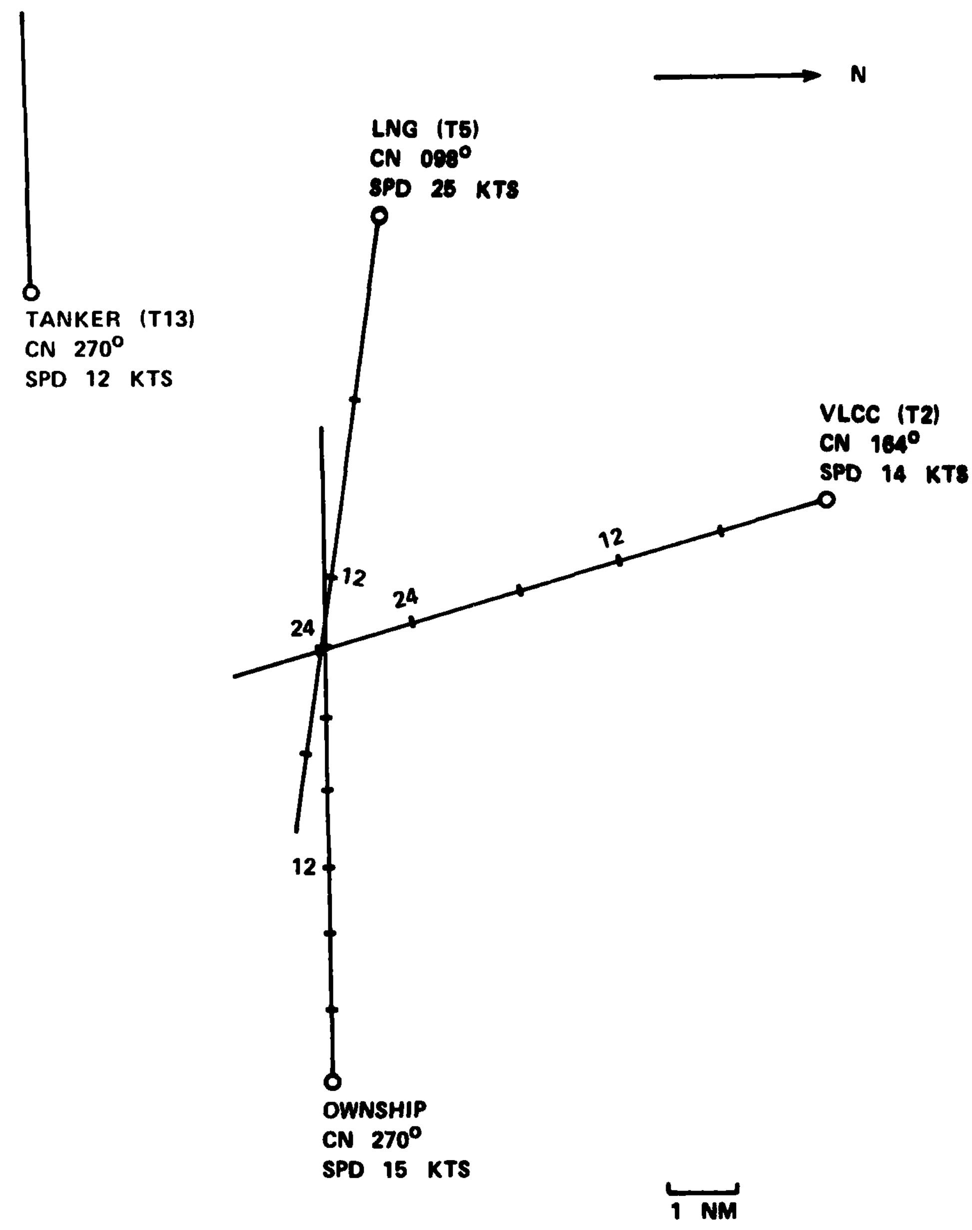


Figure A-11 Scenario 11

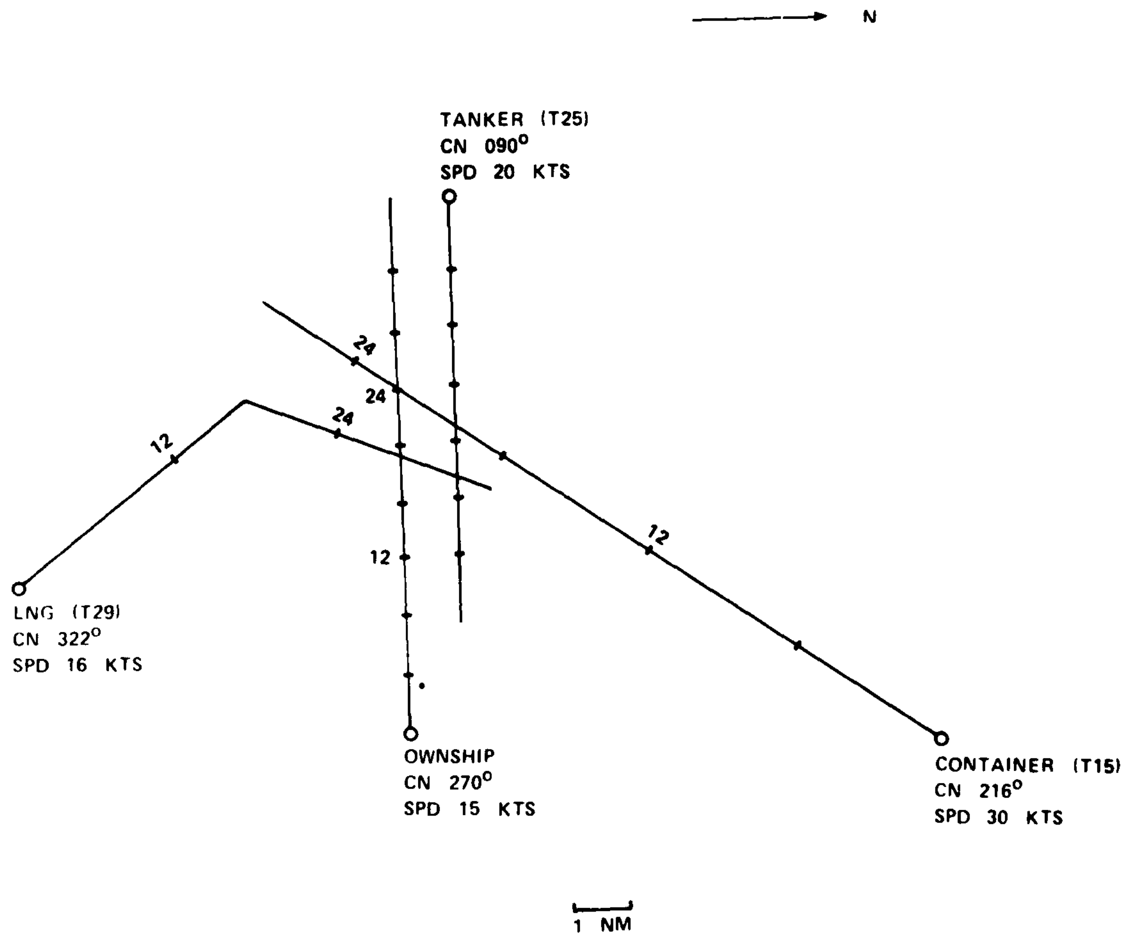


Figure A-12. Scenario 12

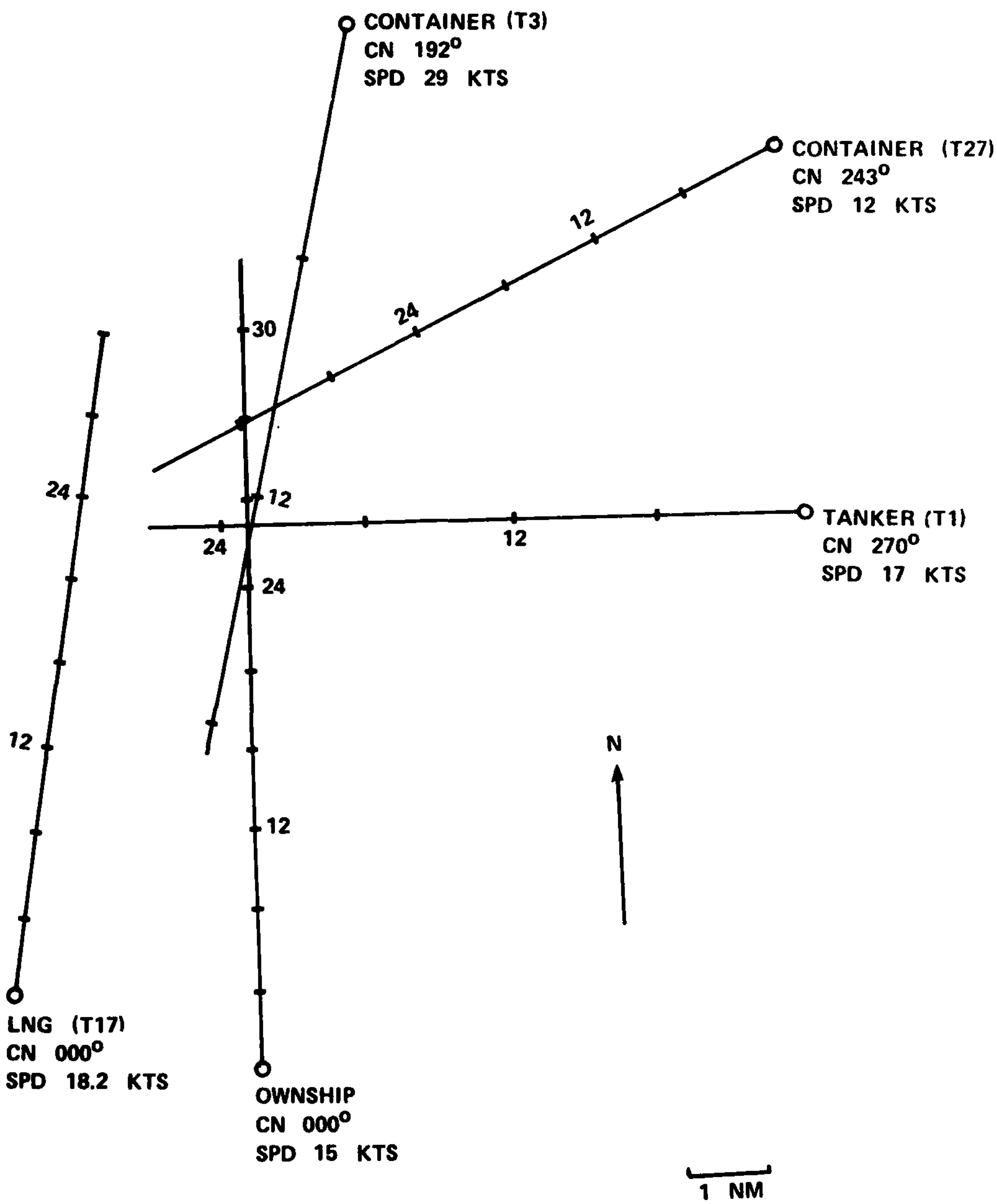


Figure A-13. Scenario 13

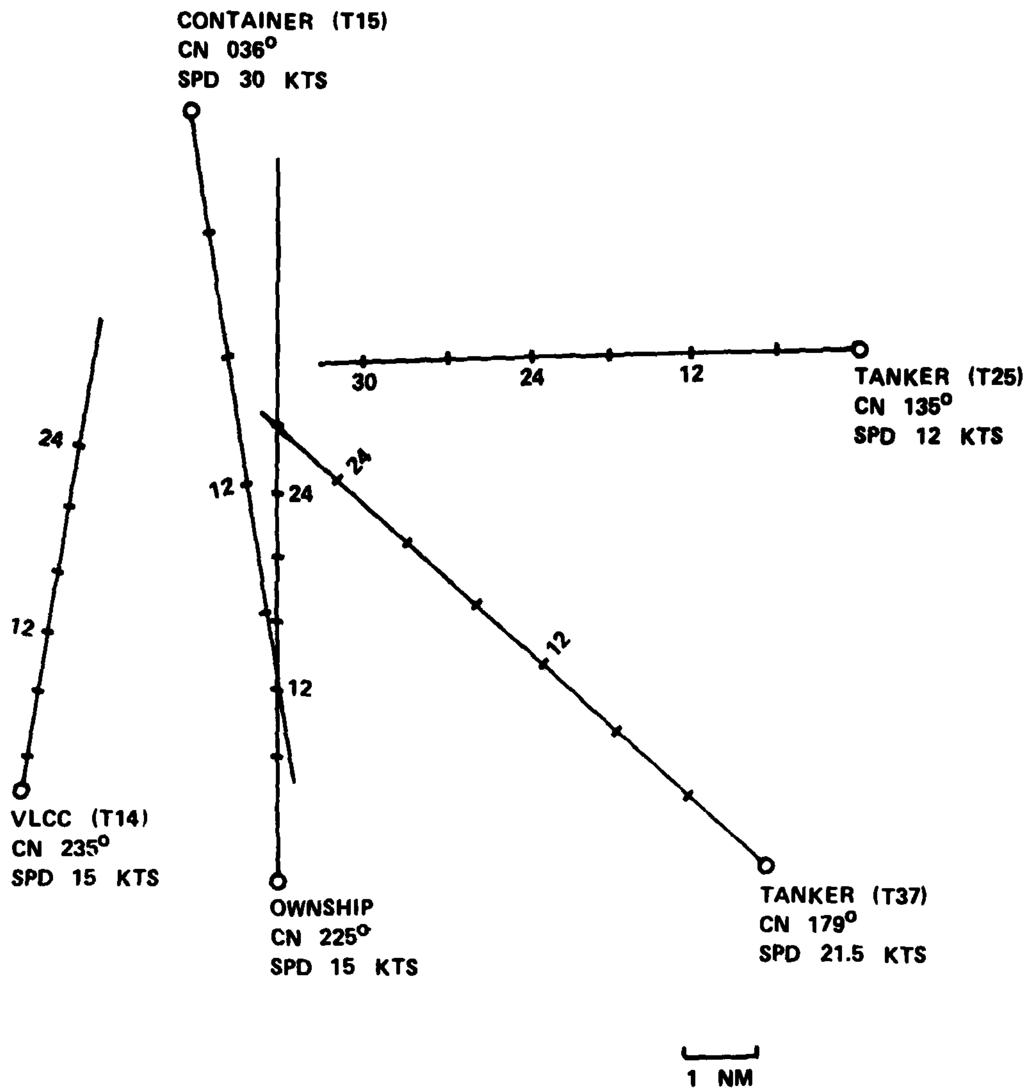


Figure A-14. Scenario 14

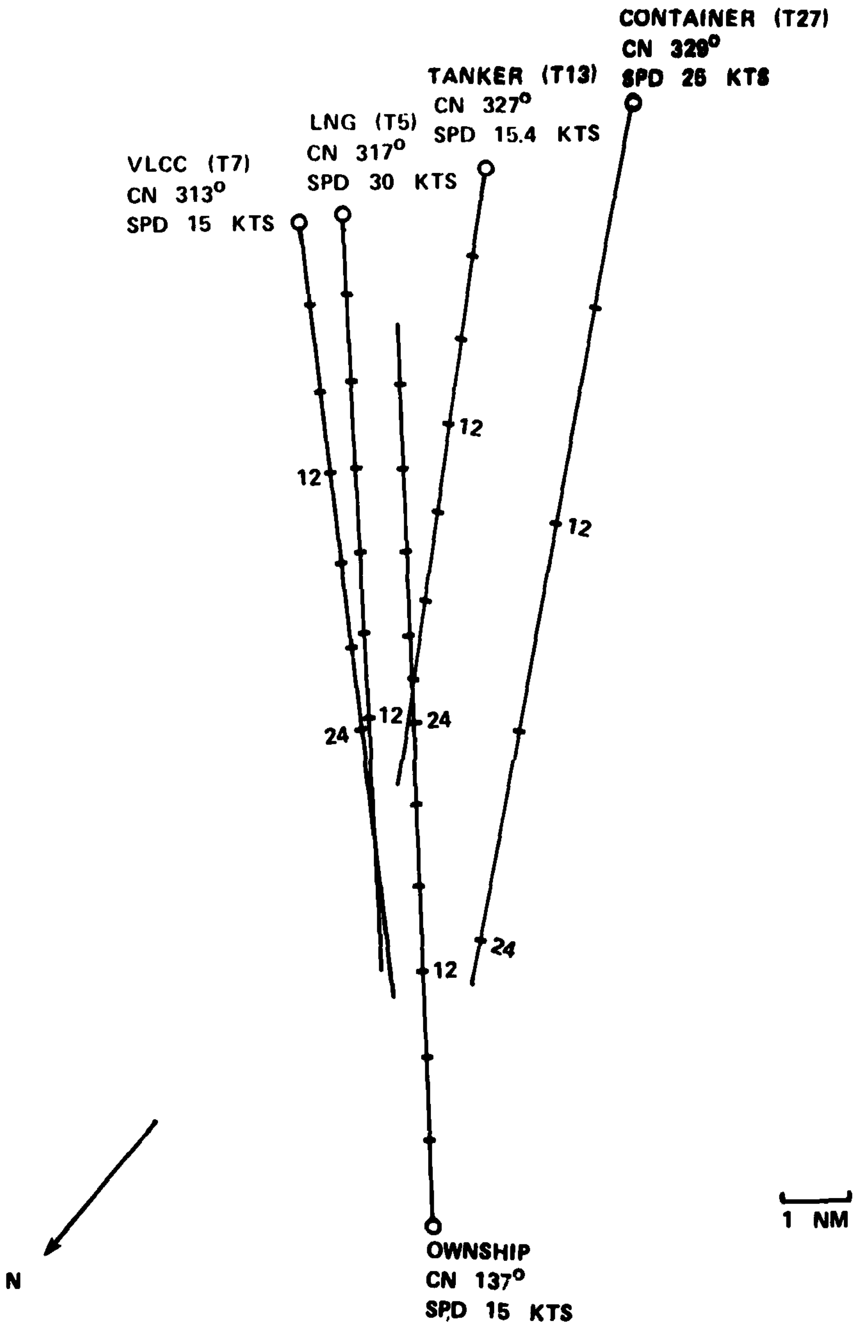


Figure A-15. Scenario 15

SEGMENT B4V

Restriction: Yes
Situation: Simple
Target: Ambiguous

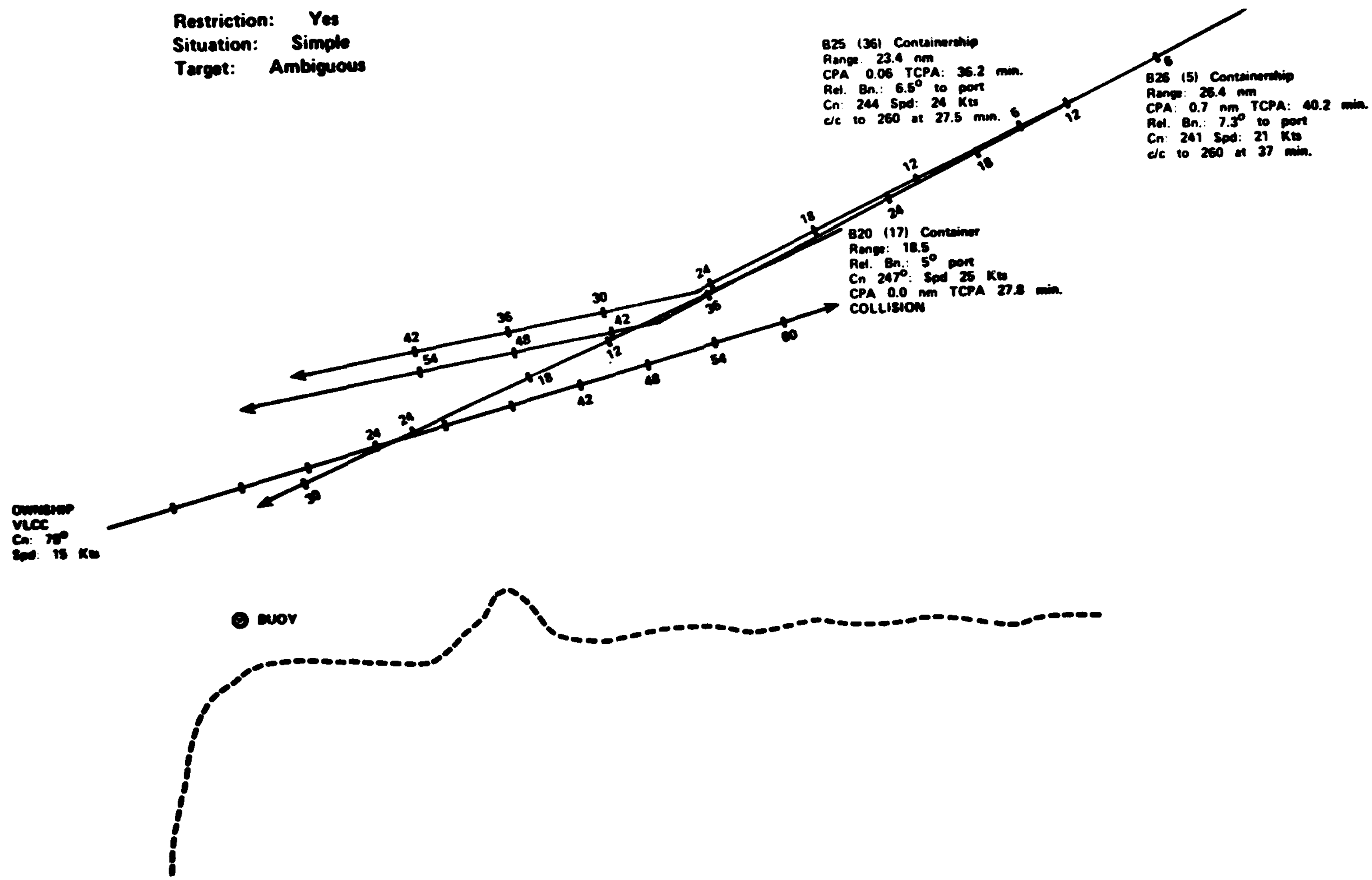


Figure A-16. Scenario 16

SEGMENT B1V

Restriction: No
Situarion: Multiple
Target: Ambiguous

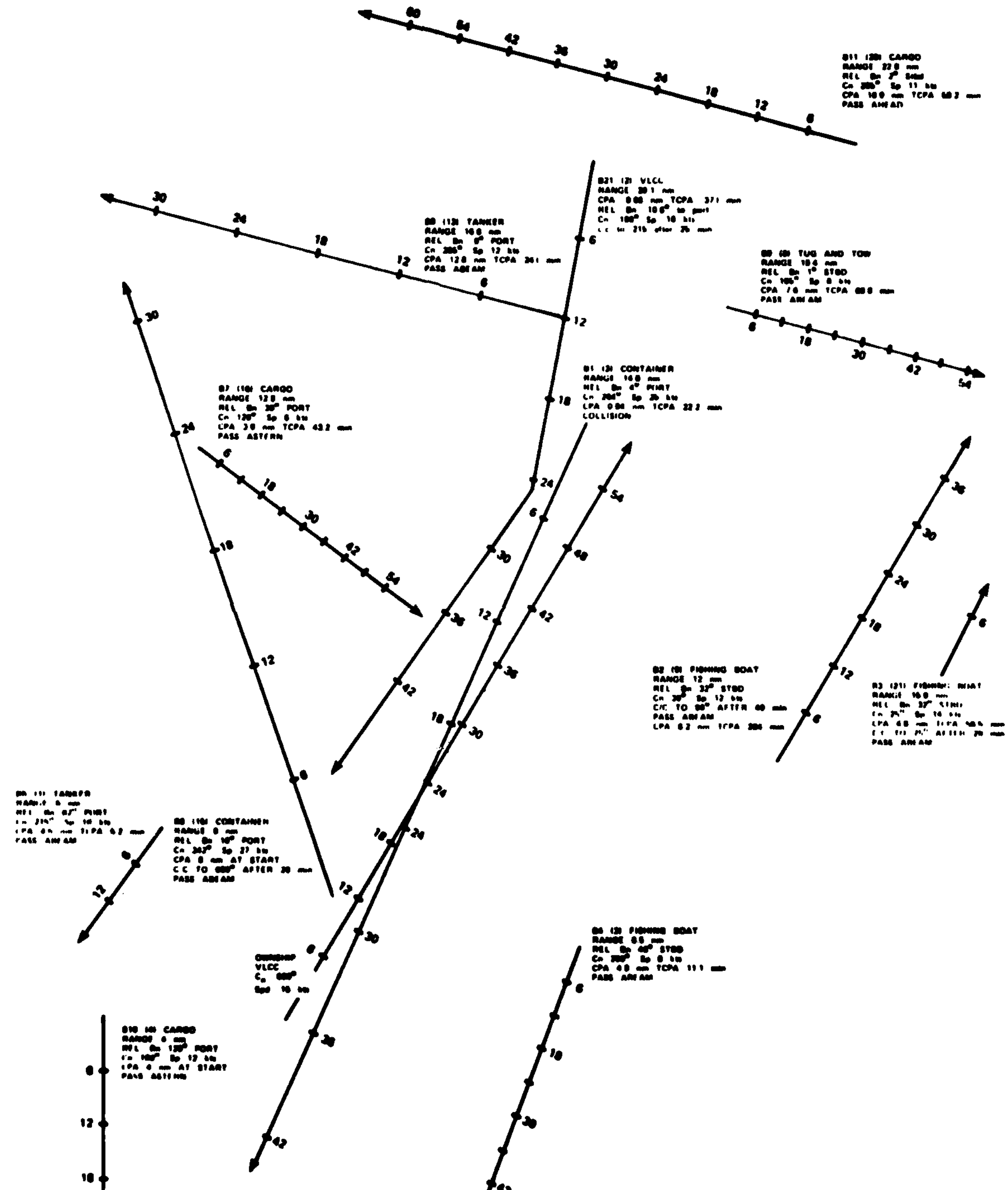


Figure A-17. Scenario 17

PORT APPROACH SCENARIOS

SCENARIO 18	Current Magnitude	1.5 kts
	Current Set	160^{o} (Flood)
SCENARIO 19	Current Magnitude	0.0 kts
	Current Set	N/A
SCENARIO 20	Current Magnitude	3.0 kts
	Current Set	160^{o} (Flood)
SCENARIO 21	Current Magnitude	3.0 kts
	Current Set	340^{o} (Ebb)
SCENARIO 22	Current Magnitude	1.5 kts
	Current Set	340^{o} (Ebb)

NOTES:
1. Use Phase II Port Approach Data Base (With Range)
2. Additional Data Base Modifications – None
3. Terminate Scenarios 19, 20, 21, and 22 after completion of Turn "B"
4. Terminate Scenario 18 when vessel arrives at pilot station

APPENDIX B

WRITTEN TESTS FOR COURSE D460

RULES OF THE ROAD PRETEST

1. A contact is held on radar, although not visually, at a range of 11 nm bearing 340 degrees relative. The data at this time indicates a projected CPA of less than 0.2 nm. Due to the contact's range and closing rate, risk of collision has been deemed to exist. At this time:

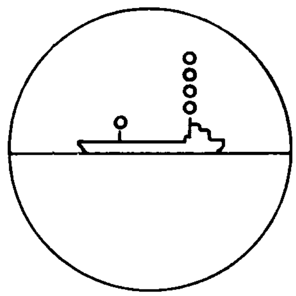
a. The stand-on vessel may maneuver since the range is large

b. The stand-on vessel must maintain her course and speed until the giveway vessel fails to take appropriate action at a later time

c. The stand-on vessel may maneuver since the giveway vessel has failed to take early and substantial action

d. None of the above

2. Section-II vessels in sight of one another.



It is clear night at sea. A ship's silhouette and lights as shown above, are seen through binoculars. The contact is also held on radar, bearing 015 degrees relative, range 6.5 nm, with CPA indicating risk of collision exists. Which of the following statements is appropriate for this situation?

a. This vessel is required to take early and substantial action to avoid our ownship

b. This vessel should take action which will avoid passing ahead of our ownship

c. This vessel is required to hold course and speed until it becomes apparent that any maneuver by our ownship alone, cannot avoid a collision

d. Our ownship should hold course and speed until it becomes apparent that any maneuver by this vessel alone, cannot avoid a collision

e. If our ownship continues to hold course and speed, and the range closes significantly, this contact is permitted to make a substantial maneuver, altering course to port, should her draft constrain a turn to starboard

3. The new rules contain the suggestion that the stand-on vessel should not alter course to port for a vessel on her port side.

a. True

b. False

4. Which of the following is not directly stated in the specifications for a lookout, in the new rules:

a. Must employ sight

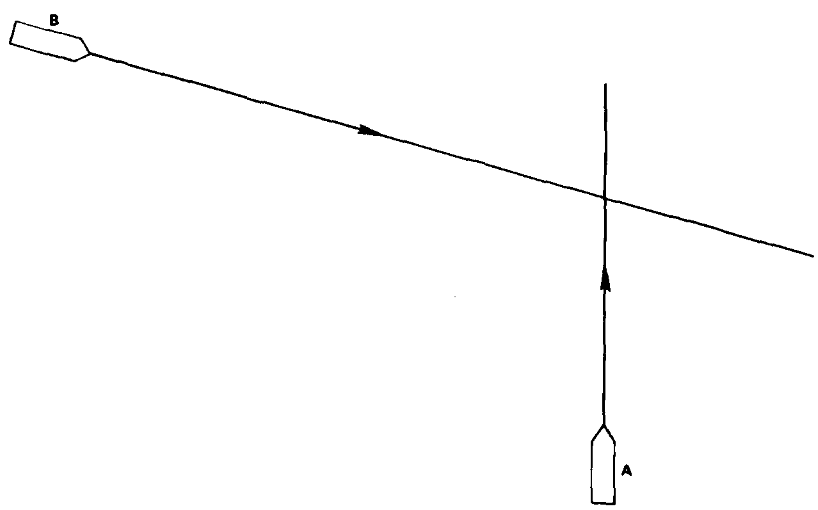
b. Must employ hearing

c. Must employ all available means in appraising the risk of collision

d. Must not be assigned any other duties which may distract from his prime responsibility

e. None of the above

5. Section II vessels in sight of one another



Vessels "A" and "B" both hold radar contact on each other and have established that risk of collision exists. No visual contact is held at this time by either vessel on the other. Neither vessel is considered "stand-on," and both are equally responsible to take early and substantial action.

a. True

b. False

6. The stand-on vessel is required to maneuver after the giveway vessel fails to take appropriate action.

a. True

b. False

7. In a head-on situation, maneuvers to port or starboard are acceptable.

a. True

b. False

8. In determining a safe speed on vessels with operational radar, provision must be made for radar plotting or equivalent systematic observation of detected objects.

a. True

b. False

9. By observing her colored sidelight, the heading of a vessel may be determined within:

a. 6 points of the compass

b. 10 points of the compass

c. 4 points of the compass

d. 8 points of the compass

10. Under the new rules, stand-on vessel action is required:

a. At an earlier point than it was under the old rules

b. At the same point it was under the old rules

c. At a later point than it was under the old rules

d. None of the above

11. Vessels with operational radar equipment should use long range scanning to obtain early warning on risk of collision, even if range of visibility is adequate and no radar contacts are evident.

a. True

b. False

12. Which of the following is a correct definition of "in extremis"?

a. When collision cannot be avoided by action of the giveway vessel alone

b. When the compass bearing of one vessel from the other does not appreciably change

c. When collision has become unavoidable by any actions of the vessels involved

d. There is no precise definition

13. Which of the following statements about the whistle is correct?

a. It must be sounded by steam.

b. It must be heard at least 1 mile in quiet, still air.

c. It must be placed so that the sound cannot be obstructed.

d. It must be made of good grade brass or equivalent.

14. International – Two vessels are 5 miles apart on a hazy day. You are legally in sight of one another:

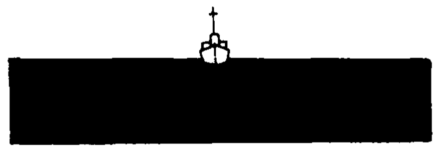
a. When seen from each other visually

b. When seen or whistle signals heard

c. When first plotted on radar

d. None of the above

15. In the given diagram, you should:



BEARING HAS CHANGED 2° IN 5 MINUTES

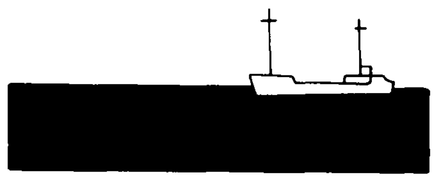
a. Blow five or more short blasts

b. Change course to port and blow two short blasts

c. Change course to starboard and blow one short blast

d. Slow down or stop

16. In the given diagram, you should:



RANGE DECREASING, BEARING STEADY

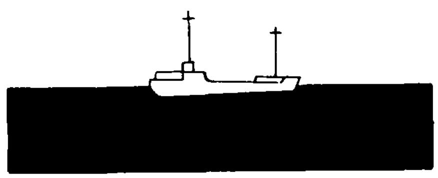
a. Change course to starboard and blow one short blast

b. Change course to port and blow two short blasts

c. Blow five short blasts to warn the other vessel

d. Hold course and speed

17. In the given diagram, you should:



RANGE DECREASING

a. Hold course and speed as you will pass clear

b. Blow the five-blast alarm signal

c. Change course to port and pass astern

d. Keep out of the vessel's way

18. Which of the following radar contacts will present the most immediate danger?

a. On the starboard bow, bearing changing, range decreasing

b. On the starboard bow, bearing steady, range decreasing

c. On the port bow, bearing steady, range decreasing

d. On the port bow, bearing changing to the left, range decreasing

19. Which is (are) true concerning danger signal?

I. In inland waters, privileged and burdened vessels must sound danger signal

II. In international waters, privileged may sound danger signal

a. I only

b. II only

c. Both I and II

d. Neither I nor II

20. With respect to sailing vessels, which of the following is true?

a. A sailing vessel overtaking is burdened

b. When seeing another sailing vessel to leeward and you could not determine its direction, hold course and speed

c. A sailing vessel on the starboard tack shall keep out of the way of other sailing vessels

d. All of the above

21. Two vessels having reciprocal courses to each other shall:

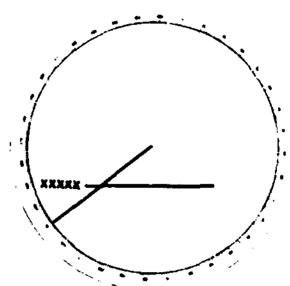
a. Alter course to starboard

b. Alter course to port

c. Sound the danger signal

d. Stop and back down

22. In thick fog, a radar screen as shown has a target plotted on the 10-mile range. You would:



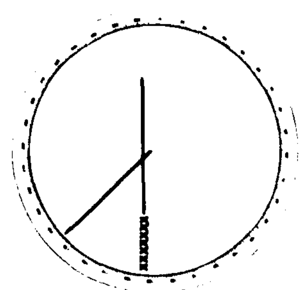
a. Make a substantial change of course to starboard

b. Hold course; there is no danger of collision

c. Reduce speed to moderate speed

d. Continue to plot; he might change course

23. The range scale is on 20 miles; the other vessel is not visible. In general, your action would be to:



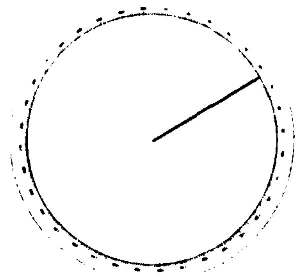
a. Change course substantially to starboard

b. Reduce speed to moderate speed

c. Continue to plot; he may take enough action to avoid a close quarter situation

d. All of the above

24. The range scale is on 20 miles; the other vessel is not visible. The action you take first would be to:



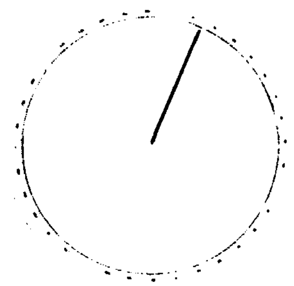
a. Reduce speed to moderate speed

b. Post a lookout forward

c. Plot the target to build up a track

d. Take no action as the target is at too far a distance to be dangerous

25. The range scale is on 10 miles; your lookout reports a vessel ahead showing steaming lights and both side lights. You look at radar and see the target. You would:



a. Take additional bearings to ascertain if risk of collision exists

b. Take no action as target is at too far a distance

c. Change course to starboard; no whistle signal is required as he is at too far a distance

d. Sound one short blast and change course to starboard

SHIPHANDLING PRETEST

1. The key to skill in shiphandling is acquired by:

a. Reducing the problem of shiphandling to a rigid mathematical formula

b. Understanding the types and strengths of the forces affecting a ship

c. Following written instructions outlined by experienced shiphandlers

d. Imitating the actions of another officer who has mastered the skill

2. A ship under power moves through the water because the:

a. Density of the water increases as it is compressed

b. Center of gravity of the ship is located forward of the bridge

c. Propellers pull the water from the bow past the stern of the ship

d. Water flows from a high-pressure to a low-pressure area

3. The phenomenon causing the formation of a hollow between the downstream surface of a moving propeller and the surrounding water is called:

a. Bifurcation

b. Vaporization

c. Separation

d. Cavitation

4. The pitch of a propeller is a measure of the:

a. Positive pressure resulting from the difference of the forces on both sides of the moving propeller in still water without a slip

b. Angle that the propeller makes with the surface of the water

c. Number of feet per revolution the propeller is designed to move in still water without slip

d. Angle that the propeller makes with a free stream of water

5. A clockwise-rotating propeller on a ship which is moving ahead will tend to:

a. Cancel out all side forces

b. Force the ship's stern to the left

c. Force the ship's stern toward the direction indicated by the sum of the various magnitudes of force

d. Force the ship's stern to the right

6. A single-screw ship will rarely back in a straight line because the:

a. Weight of the ship's afterbody unbalances the normal trim
b. Rudder cannot influence the ship's movement
c. Rotating wash from the propeller is thrown against the ship's structure
d. Bow has a tendency to rise above the water's surface

7. The force opposing the fore-and-aft movement of a ship through the water is:

a. Rudder action
b. Side force
c. Drag
d. Thrust

8. A ship steaming for 10 minutes at 6 knots will travel:

a. 1,000 yards
b. 1,500 yards
c. 2,000 yards
d. 2,500 yards

9. A ship that travels 3,000 yards in 10 minutes has a speed of:

a. 8 knots
b. 9 knots
c. 10 knots
d. 11 knots

10. Going alongside a ship at anchor is more difficult than going alongside a pier because:

a. Line throwers must be more experienced and exact
b. Yawing must be considered
c. Bitts on the anchored ship are not as strong as the bollards ashore
d. The mooring area is much smaller

11. In making a portside landing against a hard, onshore wind, it might become necessary to:

a. Let go the starboard anchor
b. Pass over the afterlines first
c. Let go the stern anchor
d. Let go the port anchor

12. The net result of the venturi effect on two ships moored together in a steady current will be to:

a. Activate whirlpools between the ships

b. Draw the two ships closer together

c. Increase the velocity of the current between the ships

d. Keep the two ships apart

13. A ship has lost steerageway when:

a. The rudder has been disengaged

b. The rudder cannot control the ship's head

c. Both engines are stopped

d. One engine is backing while the other is going ahead

14. A ship is harder to control when backing than when going ahead because the:

a. Pivot point is closer to the bow than to the stern

b. Magnitude of the forces is unpredictable

c. Stability of the hull is reduced

d. Engine cannot generate as much power in reverse

15. Bank suction is caused by the:

a. Normal tendency of water to move faster when interrupted by shore protuberances

b. Normal magnetic attraction that exists between large metal masses

c. Increased velocity of the water on the side of the ship nearer the bank, resulting in a lessening of surface tension of the water between the ship and the bank

d. Increased velocity of the water on the side of the ship nearer the bank, resulting in a lower water level on that side

16. A ship moving in a canal having a swift current may find it dangerous to turn around a bend:

a. Against the current because the rudder has less control over the movement of the ship

b. With the current because the bank effect and bank suction will be increased

c. Against the current because the current may engage the inboard bow thereby retarding the turn

d. With the current because the effects of sinking or squatting are more pronounced

17. One of the major difficulties met by the captain of a ship moving at night in a restricted harbor is the:

a. Danger of being blinded by sudden spotlights

b. Lack of seaman's eye information

c. Lack of navigational aids

d. Danger of colliding with other ships

18. Squat occurs because the:

a. Bow is buoyed up as it is lighter and more streamlined than the stern

b. Stern begins to sink as the propellers drive deeper into the water

c. Trough of the bow wave coincides with the trough caused by the propellers

d. Forward motion of the ship drives all ballast and fuel to the after end of each tank

19. A current is moving from north to south at a speed of 2 knots. The direction of the current is expressed as:

a. Drift

b. Dip

c. Set

d. Sail

20. If a collision is inevitable and a clearing course is not recognizable, the ship should:

a. Secure her engines and turn toward the danger

b. Back emergency and turn toward the danger

c. Go ahead full and turn away from the danger

d. Secure her engines and turn away from the danger

21. Which of the following statements best describes the action to take when two vessels are approaching each other end on or nearly so at a safe distance?

a. Both vessels are burdened and both ordinarily should come right and pass port to port

b. Both vessels should slow and pass starboard to starboard

c. The burdened vessel should slow and wait to see what action is taken by the privileged vessel

d. The privileged vessel should maintain course and speed

22. When heading on a course, you put your rudder hard over. The distance traveled in the direction of the original course from when you put your rudder over until your heading differs by 90 degrees is known as:

a. Transfer

b. Head reach

c. Advance

d. Tactical diameter

23. When heading on a course, you put your rudder hard over. The distance traveled perpendicular to your original heading from when you put your rudder over until your heading differs by 90 degrees is known as:

a. Tactical diameter

b. Advance

c. Head reach

d. Transfer

24. While a U.S. pilot is onboard, you should:

a. Listen for, relay, follow, and log all engine and steering orders

b. Keep a check on the vessel's position at all times since you are still responsible for the vessel while standing your watch

c. Inform the master when in doubt as to the safety of the ship

d. All of the above

25. The pilot, while onboard and entering a U.S. port, is to be considered as:

a. An advisor to the master

b. The one completely in charge and responsible for the navigation of the vessel

c. Both a and b

d. Neither a nor b

RADAR PLOTTING PROBLEMS PRETEST

1. Our course 355 degrees true, speed 12 knots. A contact is observed bearing 055 degrees true. Distance off 12 miles, at 1015. At 1027, the bearing was found to have changed to 054 degrees true distance off 9 miles. By using the relative plot, we want to find the closest point of approach, and time of closest point of approach. By use of the "Vector Diagram" or "Speed Triangle," we want to find the true speed and course of the target.

We wish to keep all contacts at a distance of at least 3 miles. By the use of a second "Vector Diagram" or "Speed Triangle," we will find course and speed change to be made at 1033, for contact to clear ahead, in minimum time.

Find:

a. Closest point of approach __________

b. Relative speed __________

c. Time closest point of approach __________

d. True course of contact __________

e. True speed of contact __________

f. Crossing distance on old course __________

g. Course change __________

h. Crossing distance on new course __________

i. Speed change on original course __________

2. Our course 045 degrees
   Our speed 15 knots

Time	Bearing	Range		
			What type of situation is it?	______
			Closest point of approach	______
2000	120 degrees	15 miles	Relative speed	______
2012	120 degrees	11 miles	Time CPA	______
2018	120 degrees	9 miles	Target true course	______
			Target true speed	______
			New course	______
			New relative speed	______

Find new course change for target to clear ahead in minimum time with a CPA of 2 miles. Time of course change 2024.

3. Our course 180 degrees
   Our speed 22 knots

Time	Bearing	Range
0436	235 degrees	18 miles
0442	234-1/2 degrees	15.2 miles
0448	233-1/2 degrees	12.5 miles

Find new course for contact to clear ahead in minimum time with a CPA of 4 miles. Take action when range decreases to 8 miles.

a. What will happen with respect to you in the center? ____________________

b. What is the bearing and range of CPA? ____________________

c. What is the relative speed? ____________________

d. Time CPA ____________________

e. Determine contact's true course ____________________

f. Determine contact's true speed ____________________

g. New course ____________________

h. New relative speed ____________________

4. Our course 090 degrees
   Our speed 12 knots

Time	Bearing	Range		
			Closest point of approach	____________
			Relative speed	____________
M1 0800	100 degrees	10 miles	Time CPA	____________
M2 0806	100 degrees	8 miles	Contact true course	____________
			Contact true speed	____________
			New course	____________

Find new course required for contact to clear ahead (on our port) in minimum time with a CPA of 1 mile. Course change 0812.

5. Our course 150 degrees
   Our speed 15 knots

Time	Bearing	Range		
			Closest point of approach	____________
			Relative speed	____________
M1 1000	50 degrees	15 miles	Time CPA	____________
M2 1015	52 degrees	11 miles	Contact true course	____________
			Contact true speed	____________
			New course	____________
			New relative speed	____________

Find new minimum course change required for contact to clear ahead in maximum time with a CPA of 3 miles. Change course at 1022.5.

RULES OF THE ROAD POSTTEST

1. The rules regarding stand-on vessel action contain a specific statement noting that these rules do not relieve the giveway vessel of her obligation to keep out of the way.

a. True

b. False

2. Emphasis to avoid crossing ahead of the stand-on vessel, which was present in the old rules, has been removed from the new rules. It has been replaced with a requirement for "appropriate" action by the giveway vessel.

a. True

b. False

3. The phrase "early and substantial action" applies to:

a. Action by the stand-on vessel to avoid collision after the giveway vessel fails to take appropriate action

b. Action by the giveway vessel to avoid collision

c. Action by both vessels to avoid collision in a head-on situation

d. Action by an overtaking vessel to avoid collision

4. Which of the following statements describe a head-on situation?

a. When two power-driven vessels are meeting on reciprocal or nearly reciprocal courses so as to involve risk of collision

b. When a vessel sees the other ahead or nearby ahead and both side lights are visible, or the corresponding aspect exists during the day

c. When risk of collision exists between two vessels and the relative bearing between the vessels is 15 degrees or less

d. a and b

e. a and c

5. A radar contact has just been detected bearing 035 degrees relative off the starboard bow, at a range of 9.8 nm. Which of the following statements is most correct in evaluating risk of collision with this contact?

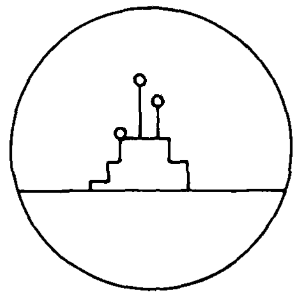
a. Radar plotting procedures should commence at radar detection.

b. Radar plotting procedures should commence when the contact is visually sighted.

c. Radar plotting procedures should be employed only if the contact shows no appreciable bearing change in the first 3 to 6 minutes of observation.

d. Radar plotting procedures are not required when the range of visibility is adequate.

6. Section II vessels in sight of one another



The stand-on vessel in a crossing situation determines that the giveway vessel is not taking appropriate action to keep out of the way. The stand-on vessel is ____________.

a. Required to hold course and speed until the action of the giveway vessel alone cannot avoid a collision

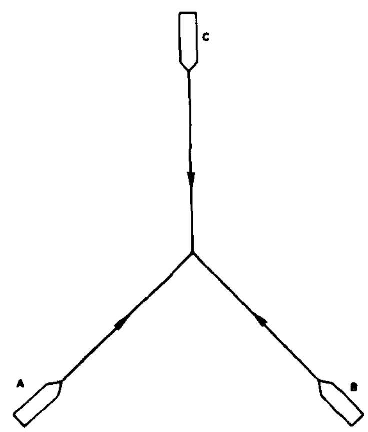
b. Permitted to take action at that point when her maneuver alone will avoid a collision

c. Permitted to take action at that point when it is determined that the giveway vessel is not taking appropriate action to keep out of the way

d. Permitted to take action at that point when it is determined that risk of collision exists

e. b and c

7.



Three vessels are converging in the open ocean as shown above. Each vessel holds radar and visual contact on the other two, and the possibility of a multiship collision exists. Which of the following statements is not appropriate to this interaction?

a. An alteration of course and/or speed by any of the three vessels should be readily apparent to either of the other two vessels, observing visually or by radar.

b. If there is sufficient sea room, an alteration of course by all of the three vessels may be the most effective action to avoid this close quarters situation, provided it is substantial and in good time and does not result in another close quarters situation.

c. Each of the three vessels is responsible to ensure that any action taken results in a safe passing distance on the other two vessels. The effectiveness of the action shall be carefully checked until the other two vessels are finally passed and clear.

d. Each vessel is "stand-on" with respect to the ship on her own port side, and also "giveway" with respect to the ship on her own starboard side.

8. The new rules specify that "risk of collision" begins to exist when the target is visually detected.

a. True

b. False

9. When is action by the stand-on vessel required under the new rules?

a. Before the point at which the stand-on vessel can no longer avoid the collision by her actions alone

b. After the point at which the giveway vessel fails to take appropriate action

c. After the point at which the collision can no longer be avoided by the actions of the giveway vessel alone

d. Before the point at which the collision cannot be avoided by the actions of the giveway vessel alone

e. a and b.

10. The rules permit stand-on vessel action:

a. At a point earlier than under the old rules

b. At the same point as permitted under the old rules

c. At a point later than permitted under the old rules

11. Which of the following statements is untrue?

a. "Risk of collision" applies in all conditions of visibility.

b. Giveway and stand-on vessels designations are applicable only to vessels in sight of each other.

c. The requirement for safe speed applies only when vessels are in sight of each other.

d. Head-on and crossing situations are applicable only when vessels are in sight of each other.

12. In determining a safe speed on vessels with operational radar, provision must be made for the possibility that small vessels, ice, and other floating objects may not be detected by radar at an adequate range.

a. True

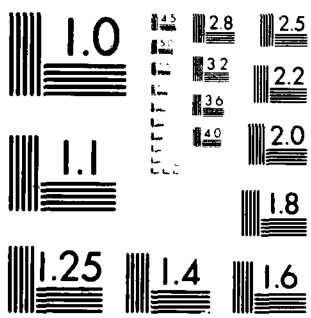
b. False

AD-A114 747 NATIONAL MARITIME RESEARCH CENTER KINGS POINT NY COM--ETC F/G 5/9
SIMULATORS FOR MARINER TRAINING AND LICENSING. PHASE 3: INVESTI--ETC(U)
DEC 81 T J HAMMELL, J W GYNTHER, J A GRASSO

UNCLASSIFIED CAORF50-8004-01 USCG-D-07-82 NL

2 of 2

END
DATE
FILMED
6 82
DTIC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A

13. A radar contact at 348 degrees relative is also held visually about one point off the port bow. The radar plot indicates a very close CPA, slow right bearing drift; and risk of collision is evident. The contact is showing a mast head light, range light, and a side light. Stern light is not visible.

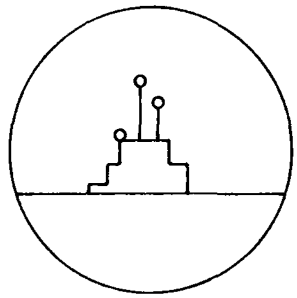
a. An ambiguous situation and cannot be established as head-on, crossing, or overtaking

b. A head-on situation

c. A crossing situation

d. An overtaking situation

14. Section II vessels in sight of one another



It is a bright night in the open sea. A ship's silhouette and navigation lights as shown above are seen through binoculars. The radar is inoperative and out of commission. The visual bearing is now 352 degrees relative and has not changed appreciably since this vessel was first observed. Range is estimated at about 5 nm. Which of the following statements does not apply?

a. This is a crossing situation, and our ownship is the stand-on vessel.

b. This is a head-on situation, and our ownship and the other vessel should alter course to starboard in order to pass clear, port to port.

c. Our ownship should hold course and speed at the present time.

d. This is a crossing situation, and the contact is the giveway vessel.

e. Answers a, c, and d do not apply. Answer b represents this situation.

15. One factor in defining a head-on situation is the target's aspect. Regard aspect, a head-on situation exists when both of the target's side lights can be seen or when the target has the corresponding aspect during the day. This aspect is within ± 3 degrees of the target's bow.

a. True

b. False

16. Which of the following would not be considered as positive action taken in ample time to avoid collision.

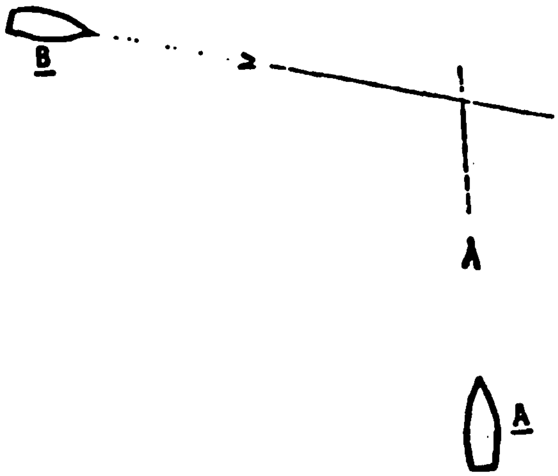
a. Slowing speed, taking all way off, or reversing propulsion

b. A succession of small course and/or speed changes to avoid a close quarters situation

c. Early selection of a safe passing distance

d. Alteration of course alone with sufficient sea room

17. Section II vessels in sight of one another



Vessels "A" and "B" both hold radar contact on each other and have established that risk of collision exists. No visual contact is held at this time on vessel "B" by vessel "A." This is a crossing situation; "A" is the stand-on vessel, and "B" is the giveway vessel.

a. True

b. False

18. A VLCC is observed one point off the port bow at a range of 4 nm in a crossing situation. Which of the following conclusions in evaluating this vessel would be most correct?

a. This vessel may be severely restricted in ability to deviate from the course she is following because of draft regardless of the available depth of water.

b. This vessel is not restricted in ability to deviate from the course she is following, providing a sufficient depth of water exists.

c. This vessel may be severely restricted in her ability to maneuver by the nature of her work.

d. This vessel should be expected to depart from the rules because of vessel limitations.

19. You are on vessel I in the situation shown. Which of the following statements is correct?

I. You should alter course to port.

II. You should sound two short blasts.

a. I only

b. II only

c. Both I and II

d. Neither I nor II

20. Every vessel which is directed by these rules to keep out of the way of another vessel shall do all of the following except:

a. Take positive early action to comply with this obligation

b. Avoid crossing ahead

c. Blow two short blasts

d. Slow down, stop, or reverse, if necessary

21. Which of the following is the term meaning a situation when collision cannot be avoided by action of the giveway vessel alone?

a. In personam

b. In extremis

c. Collision imminent

d. Vis major

22. Whistle signals indicating course changes must be sounded:

a. In fog

b. When vessels are in sight of one another

c. When you can be reasonably sure of hearing the other vessel's acknowledgement

d. Every time you alter course

23. Vessels shall be deemed to be in sight of one another when:

I. One can be seen visually from the other.

II. The other's lights are seen at night.

a. I only

b. II only

c. Both I and II

d. Neither I nor II

24. The rule of special circumstances supplements the rules of the road with additional precautions not ordinarily required. These precautions may allow or require:

I. Violation of a requirement of the other rules.

II. Action beyond full obedience to the rules.

a. I only

b. II only

c. Both I and II

d. Neither I nor II

25. Which of the following radar contacts will present the most immediate danger?

a. On the starboard bow, bearing changing, range decreasing

b. On the starboard bow, bearing steady, range increasing

c. On the port bow, bearing not changing, range decreasing

d. On the port bow, bearing changing to the left, range decreasing

SHIPHANDLING POSTTEST

1. The forces of wind and current cannot be controlled from the ship, but the shiphandler can compensate for these factors by using:

a. Rudders

b. Propellers and ground tackle

c. Mooring lines

d. All of the above

2. Which of the following factors affects the amount of lift exerted by a given rudder?

a. Inclination of the rudder

b. Velocity of the water flowing past the rudder

c. Location of the rudder

d. All of the above

3. The wind will have greatest effect upon a ship with which of the following characteristics?

a. Low freeboard and a shallow draft

b. Low freeboard and a deep draft

c. High freeboard and a deep draft

d. High freeboard and a shallow draft

4. A closewise-rotating propeller on a ship which is moving ahead will tend to:

a. Cancel out all side forces

b. Force the ship's stern to the left

c. Force the ship's bow toward the direction indicated by the sum of the various magnitudes of force

d. Force the ship's stern to the right

5. The force opposing the fore-and-aft movement of a ship through the water is called:

a. Rudder action

b. Side force

c. Drag

d. Thrust

6. On most ships, the engine order STOP means to:

a. Reduce the steam pressure on the turbines until all way is lost
b. Reverse the screws until the ship is dead in the water
c. Close all throttles and prevent the propellers from turning
d. Close all throttles and let the propellers idle

7. What order should be given to the helmsman if 10 degrees left rudder is desired?

a. LEFT, 10 DEGREES RUDDER
b. LEFT RUDDER, 10 DEGREES
c. RUDDER LEFT 10 DEGREES
d. TEN DEGREES LEFT RUDDER

8. A ship has lost steerageway when:

a. The rudder has been disengaged
b. The rudder cannot control the ship's head
c. Both engines are stopped
d. One engine is backing while the other is going ahead

9. Which of the following maneuvers should result in the quickest rescue of a man who has fallen overboard during daylight?

a. The Williamson turn
b. Twisting ship by opposing the engines
c. Backing full on the engines until the man is reached
d. The continuous full rudder turn

10. The surest way to return to the position of a man overboard at night is to:

a. Back down full on both engines, keeping the rudder amidships
b. Go full ahead on one engine and back the other
c. Use the full rudder method
d. Use the Williamson turn method

11. What does a harbor range mark?

a. The turning point of the main channel
b. The danger bearings of shoal water
c. The side of the channel opposite the buoys
d. The center of the main channel

12. The direction in which the combined forces of wind and current are acting is called:

a. Set

b. Eddy

c. Run

d. Drift

13. A moving ship in a channel can best determine the direction and velocity of the current by:

a. Observing the wake past a channel marker

b. Following the course of a piece of wood dropped over the side

c. Estimating the size of the bow wave

d. Comparing the ship's speed with that computed at the pit log

14. What effect does bank effect have on a ship?

a. It draws the ship bodily into the bank.

b. It pulls the bow into the bank.

c. It makes the ship steer away from the bank.

d. It creates a drag on the ship.

15. To overcome the combined actions of bank suction and bank effect, a ship should:

a. Increase the rpm of the screw on the side facing the near bank

b. Carry several degrees of rudder away from the near bank

c. Stop the screw on the side facing the far bank

d. Carry several degrees of rudder toward the near bank

16. A current is moving from north to south at a speed of 2 knots. The direction of the current is expressed as:

a. Drift

b. Dip

c. Set

d. Sail

17. The velocity of a current is expressed as:

a. Sail

b. Drift

c. Dip

d. Set

18. Shifting the rudder from side to side to aid the deceleration of the ship is called:

a. Floundering

b. Cantering

c. Zigzagging

d. Fishtailing

19. "Crabbing" is the term applied to the:

a. Weaving motion produced by the ship's bow as the rudder is shifted from side to side

b. Yawing produced by a ship as she attempts to follow a path around a circle

c. Uncertain movement of a ship responding to rapid directional changes in her screws

d. Sidewise motion imparted to a ship as a result of wind or current

20. A ship approaching a narrow drawbridge opening during a strong wind keeps a steady bearing on the opening. The cross-channel angle may be measured as the angle between the:

a. Ship's head and the bearing to the center of the opening

b. The centerline of the channel and the relative bearing of the wind

c. Ship's head and the bearings of both sides of the opening

d. Bearing of the center of the opening and the relative bearing of the wind

21. If it is determined that the cross-channel angle is too large to assure safe passage through a drawbridge opening, a ship may reduce the angle by:

a. Keeping the wind abaft her quarters

b. Increasing speed

c. Decreasing speed

d. Commencing her turn before the opening is reached

22. A ship may also nullify the cross-channel effect referred to above by:

a. Stopping and allowing the current to carry the ship through the opening

b. Swinging parallel to the channel when arriving at the restriction

c. Continuously shifting the rudder to set up bow waves against the sides of the opening

d. Steering a course halfway between the relative direction of the wind and current

23. If a collision is inevitable and a clearing course is not recognizable, the ship should:

a. Secure her engines and turn toward the danger

b. Back emergency and turn toward the danger

c. Go ahead full and turn away from the danger

d. Secure her engines and turn away from the danger

24. When heading on a course, you put your rudder hard over. The distance traveled in the direction of the original course form when you put your rudder over until your heading differs by 90 degrees is known as:

a. Transfer

b. Head reach

c. Advance

d. Tactical diameter

25. The key to skill in shiphandling is acquired by:

a. Reducing the problem of shiphandling to a rigid mathematical formula

b. Understanding the types and strengths of the forces affecting a ship

c. Following written instructions outlined by experienced shiphandlers

d. Imitating the actions of another officer who has mastered the skill

RADAR PLOTTING POSTTEST

Use radar plotting sheet.

1. Ownship on course 000, speed 15 knots obtains the following radar bearings and ranges of the same pip at the time indicated:

Time	Bearing	Range
0800	045	19.0
0806	046	16.7
0812	048	14.0

Find:

a. If ownship's close quarter zone is 3.0 miles, is the other ship approaching so as to involve a close quarters situation? ________________

b. What type of situation is it? ________________

c. CPA range? ________________

d. CPA bearing? ________________

e. Time of CPA? ________________

f. Other ship's course? ________________

g. Other ship's speed? ________________

2. Ownship on course 063, speed 14 knots obtains the following radar bearings and ranges of the same pip at the time indicated:

Time	Bearing	Range
1012	044	16.0
1018	042	14.7
1024	040	13.4

Find:

a. If ownship's close quarter zone is 4.0 miles, is the other ship approaching so as to involve a close quarters situation? ________________

b. What type of situation is it? ________________

c. CPA range? ________________

d. CPA bearing? ________________

e. Time of CPA? ________________

f. Other ship's course? ________________

g. Other ship's speed? ________________

3. Ownship on course 245, speed 16 knots, obtains the following radar bearings and ranges of the same pip at the time indicated:

Time	Bearing	Range
1517	030	10.0
1525	034-1/2	9.0
1533	040	8.0

Find:

a. If ownship's close quarter zone is 3.0 miles, is the other ship approaching so as to involve a close quarters situation? ____________________

b. What type of situation is it? ____________________

c. CPA range ____________________

d. CPA bearing ____________________

e. Time of CPA ____________________

f. Other ship's course ____________________

g. Other ship's speed ____________________

APPENDIX C

STUDENT HANDOUTS

COURSE – D460: BRIDGE WATCHSTANDING (SIMULATOR-BASED TRAINING

STUDENT HANDOUT – CLASS 1

COURSE DESCRIPTION

D460: Bridge Watchstanding (Simulator-Based Training)

General

D460: Bridge Watchstanding (Simulator-Based Training) is a three (3) credit elective course to enhance the potential 3rd mate's decisionmaking skills as applied to traffic and restricted waterways situations. It is a 9 week course consisting of two training modules. The first 5 weeks are devoted to international rules of-the-road while the second 4 weeks are devoted to port approach planning. During both modules there will be a 50/50 mix of classroom and simulator time. The class will meet 2 days per week for 3-hour sessions (see Course Schedule).

Rules-of-the-Road Unit

The rules-of-the-road training module will address vessel handling when in a potential collision situation. The three basic open-sea situations to be studied will be:

- Crossing situation with ownship as giveway vessel
- Crossing situation with ownship as stand-on vessel
- Meeting/ambiguous situation

Prior to the training program all students will be administered two written tests and one simulator test to determine their entry level proficiency. The written tests will be given on rules-of-the-road (international) and radar plotting.

Lesson plans, audio/visual aids, and case studies have been developed for the above situations. The specific issues to be addressed during this training module will be:

- Interpretation of the rules
- Determination of threat vessel(s)
- When to call the master
- When to initiate a maneuver
- Type and amount of maneuver
- Achieved CPA
- Bridge procedures
- Shiphandling characteristics

After the training program all students will again be administered two written tests and one simulator test. These tests will be equivalent versions of the pre-training tests.

Port Approach Planning Unit

The port approach planning training module will address the navigation of an 80,000 dwt tanker (loaded) into and through a restricted channel under various wind

conditions. Students will be required to plan every segment of the "voyage" including: courses to steer, estimated time of arrival (ETA), effects of wind on the vessel, use of navigational aids and VHF communications. Students will then be divided into teams of three:

- Master
- Radar observer
- Navigator

Each team will have the opportunity to execute their plans on the simulator. The first plan and approach of each team will be considered the pre-training test while the last plan and approach will be considered the post-training test.

The specific issues to be addressed during the training will include:

- The approach plan
- Any necessary departure from the plan
- Shiphandling
- Current effects
- Bridge procedures

Essay Requirement

On the last day of the training course (see Course Schedule) all students will also be required to submit a typed essay (minimum 4 to 6 pages) on the following topic:

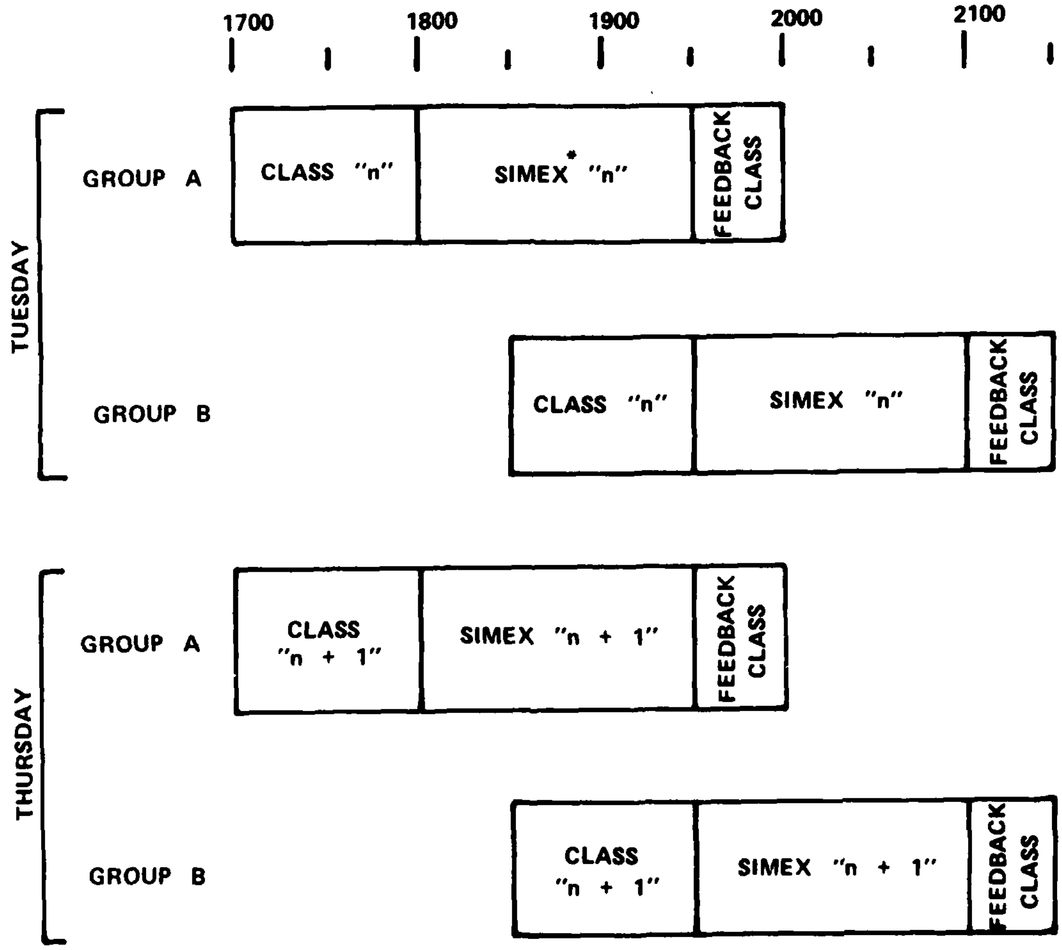
> "A Subjective Comparison Between Midshipman Simulator-Based Training and Midshipman At-Sea Training"

This essay should concisely evaluate the role of both simulator-based training and at-sea training within the USMMA curriculum. It is suggested that the paper address one or more of the following issues:

- Advantages and disadvantages of midshipman simulator-based training and at-sea training
- Description of recommended simulator-based courses and recommended at-sea training experiences for future midshipman training
- Proper placement (i.e., semester) of recommended simulator-based training courses and at-sea training experiences within the 4-year program.

This is not a paper which requires significant research and references. It is a paper that requires careful thought about the type, quality and potential of the simulator-based training and the at-sea training that has been received, and their places within the academy program. Questions concerning this assignment should be addressed to one of the instructors.

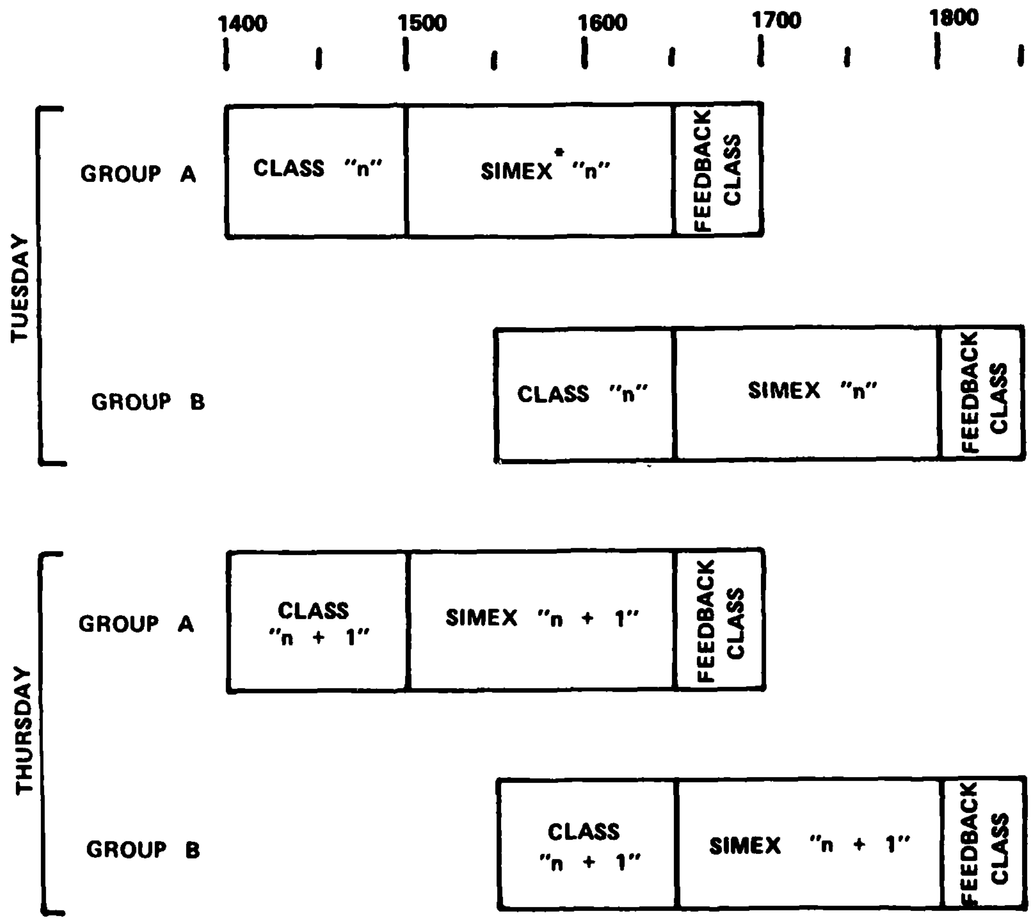
REPRESENTATIVE WEEKLY SCHEDULE
ODD WEEK



(THIS SCHEDULE IS VALID FOR WEEKS 1,3,5,7, AND 9)

*SIMEX = SIMULATOR EXERCISE

REPRESENTATIVE WEEKLY SCHEDULE
EVEN WEEK



(THIS SCHEDULE IS VALID FOR WEEKS 2,4,6, AND 8)

*SIMEX = SIMULATOR EXERCISE

PURPOSE OF EXPERIMENT

BACKGROUND

Traditionally, the "hands-on-training" of merchant marine cadets has been provided through the use of training ships or by apprentice assignments on operating merchant ships. Recently, several factors have been providing a substantial impetus for altering this training approach.

First, the expense of providing at-sea training, particularly aboard dedicated training vessels, has been accelerating rapidly. This economic factor has become increasingly important as several training vessels presently require, or will shortly require, major renovations or replacement.

Second, the specific benefits derived from the at-sea portion of a maritime cadet's training have been questioned as the costs of providing this type of training have increased. This is particularly true with regard to apprentice assignments on operating merchant ships, where the training facility has little control over the training process.

Third, the preparedness of the cadet/3rd mate has been the subject of international concern, resulting in an Intergovernmental Maritime Consultative Organization (IMCO) regulation which calls for an increase in the amount of at-sea time required prior to obtaining a 3rd mate's license (Regulation II/4, IMCO Standards of Training and Watchkeeping Convention, July 1978). The intent of this IMCO Regulation is to provide additional experience for the cadet and, hence, provide him with a higher level of skill and understanding of the at-sea situation. This requirement poses a real problem to a number of existing officer training programs which do not include this required period of at-sea time. Fortunately, the IMCO Convention contains a special provision (Article IX) which recognizes that the acquisition of at-sea time alone does not insure 3rd mate proficiency, and accepts in principle the concept of equivalent or more effective training programs.

Fourth, in recent years the technology of shiphandling simulators has been developing rapidly with constantly decreasing costs. Included among the many advantages of simulator-based training are safety, training control, and cost. Shiphandling simulators also have many limitations, typically pertaining to technical simulation capabilities (e.g., low speed hydrodynamics). However, the application of simulation to cadet training is becoming increasingly attractive.

Fifth, the Port and Tanker Safety Act of 1978 has provided an additional impetus for the accelerated implementation of mariner simulator-based training. It requires a general improvement in standards relating to the qualifications and training of officers and crew. It especially calls for the "qualification for licenses by use of simulators for the practice or demonstration of marine-oriented skills."

PROGRAM GOALS

In anticipation and response to these factors, the U.S. Coast Guard and U.S. Maritime Administration have embarked on a joint research project to "define the role of simulators in the mariner training and licensing process." This project is now in its third phase. The principal product that the Maritime Administration desires from this research is a functional specification for a cadet training simulator. The principal product that the Coast Guard desires is a basis for accrediting simulator-based training facilities, which is primarily addressed in other Phase III tasks.

APPROACH

In order to develop objective information upon which the functional specification for a cadet simulator could be based, a series of cadet training experiments are presently being conducted at the Computer Aided Operations Research Facility (CAORF). The purpose of these experiments is to investigate a wide range of issues, particularly high cost simulator characteristics, that cannot be effectively resolved through subjective analysis. The first cadet training experiment focused primarily on the issues of (a) daylight versus nighttime simulator-based training and (b) concentrated (1-week duration) versus distributed (1 academic quarter duration) simulator-based training. The results of this experiment are presently being analyzed. The principal issue to be investigated by this experiment involves the relationship between horizontal field of view and effective simulator-based training of selected navigation and shiphandling skills. Group A will be trained utilizing 240° horizontal field of view,and Group B will be trained utilizing 120° horizontal field of view.

COURSE STRUCTURE – GROUP A (240° F/V)

I. RULES-OF-THE-ROAD TRAINING MODULE

Week 1 (14-18 April)	CLASS 1:	Topic-	Introduction
	SIMEX 1:	Scenarios-	Familiarization
	CLASS 2:	Topic-	Written Pretests
	SIMEX 2:	Scenarios-	1,1,1 (Pretest)
Week 2 (21-25 April)	CLASS 3:	Topic-	None
	SIMEX 3:	Scenarios-	2,2,2 (Pretest)
	CLASS 4:	Topic-	Crossing: Ownship Giveway
	SIMEX 4:	Scenarios-	9,10,11
Week 3 (28 April-2 May)	CLASS 5:	Topic-	Crossing: Ownship Giveway
	SIMEX 5:	Scenarios-	12,13,14
	CLASS 6:	Topic-	Crossing: Ownship Stand-On
	SIMEX 6:	Scenarios-	3,4,5
Week 4 (5-9 May)	CLASS 7:	Topic-	Crossing: Ownship Stand-On
	SIMEX 7:	Scenarios-	6,7,8
	CLASS 8:	Topic-	Meeting/Ambiguous
	SIMEX 8:	Scenarios-	15,16,17,15
Week 5 (12-16 May)	CLASS 9:	Topic-	Written Posttests
	SIMEX 9:	Scenarios-	2,2,2 (Posttest)
	CLASS 10:	Topic-	None
	SIMEX 10:	Scenarios-	1,1,1 (Posttest)

II. PORT APPROACH PLANNING

Week 6 (19-23 May)	CLASS 11:	Topic-	Introduction & Written Pretests
	SIMEX 11:	Scenarios-	18 (Pretest)
	CLASS 12:	Topic-	None
	SIMEX 12:	Scenarios-	18 (Pretest)
Week 7 (26-30 May)	CLASS 13:	Topic-	Training Problem #1
	SIMEX 13:	Scenarios-	19,19
	CLASS 14:	Topic-	None
	SIMEX 14:	Scenarios-	20,20
Week 8 (2-6 June)	CLASS 15:	Topic-	Training Problem #2
	SIMEX 15:	Scenarios-	21,21
	CLASS 16:	Topic-	None
	SIMEX 16:	Scenarios-	22,22
Week 9 (9-13 June)	CLASS 17:	Topic-	Written Posttests
	SIMEX 17:	Scenarios-	18 (Posttest)
	CLASS 18:	Topic-	None
	SIMEX 18:	Scenarios-	18 (Posttest)

COURSE STRUCTURE – GROUP B (120° F/V)

I. RULES-OF-THE-ROAD TRAINING MODULE

Week 1 (14-18 April)	CLASS 1:	Topic-	Introduction	
	SIMEX 1:	Scenarios-	Familiarization	
	CLASS 2:	Topic-	Written Pretests	
	SIMEX 2:	Scenarios-	1,1,1	(Pretest)
Week 2 (21-25 April)	CLASS 3:	Topic-	None	
	SIMEX 3:	Scenarios-	2,2,2	(Pretest)
	CLASS 4:	Topic-	Crossing: Ownship Stand-On	
	SIMEX 4:	Scenarios-	3,4,5	
Week 3 (28 April-2 May)	CLASS 5:	Topic-	Crossing: Ownship Stand-On	
	SIMEX 5:	Scenarios-	6,7,8	
	CLASS 6:	Topic-	Crossing: Ownship Giveway	
	SIMEX 6:	Scenarios-	9,10,11	
Week 4 (5-9 May)	CLASS 7:	Topic-	Crossing: Ownship Giveway	
	SIMEX 7:	Scenarios-	12,13,14	
	CLASS 8:	Topic-	Meeting/Ambiguous	
	SIMEX 8:	Scenarios-	15,16,17,15	
Week 5 (12-16 May)	CLASS 9:	Topic-	Written Posttests	
	SIMEX 9:	Scenarios-	2,2,2	(Posttest)
	CLASS 10:	Topic-	None	
	SIMEX 10:	Scenarios-	1,1,1	(Posttest)

II. PORT APPROACH PLANNING

Week 6 (19-23 May)	CLASS 11:	Topic-	Introduction & Written Pretests	
	SIMEX 11:	Scenarios-	18	(Pretest)
	CLASS 12:	Topic-	None	
	SIMEX 12:	Scenarios-	18	(Pretest)
Week 7 (26-30 May)	CLASS 13:	Topic-	Training Problem #1	
	SIMEX 13:	Scenarios-	19,19	
	CLASS 14:	Topic-	None	
	SIMEX 14:	Scenarios-	20,20	
Week 8 (2-6 June)	CLASS 15:	Topic-	Training Problem #2	
	SIMEX 15:	Scenarios-	21,21	
	CLASS 16:	Topic-	None	
	SIMEX 16:	Scenarios-	22,22	
Week 9 (9-13 June)	CLASS 17:	Topic-	Written Posttests	
	SIMEX 17:	Scenarios-	18	(Posttest)
	CLASS 18:	Topic-	None	
	SIMEX 18:	Scenarios-	18	(Posttest)

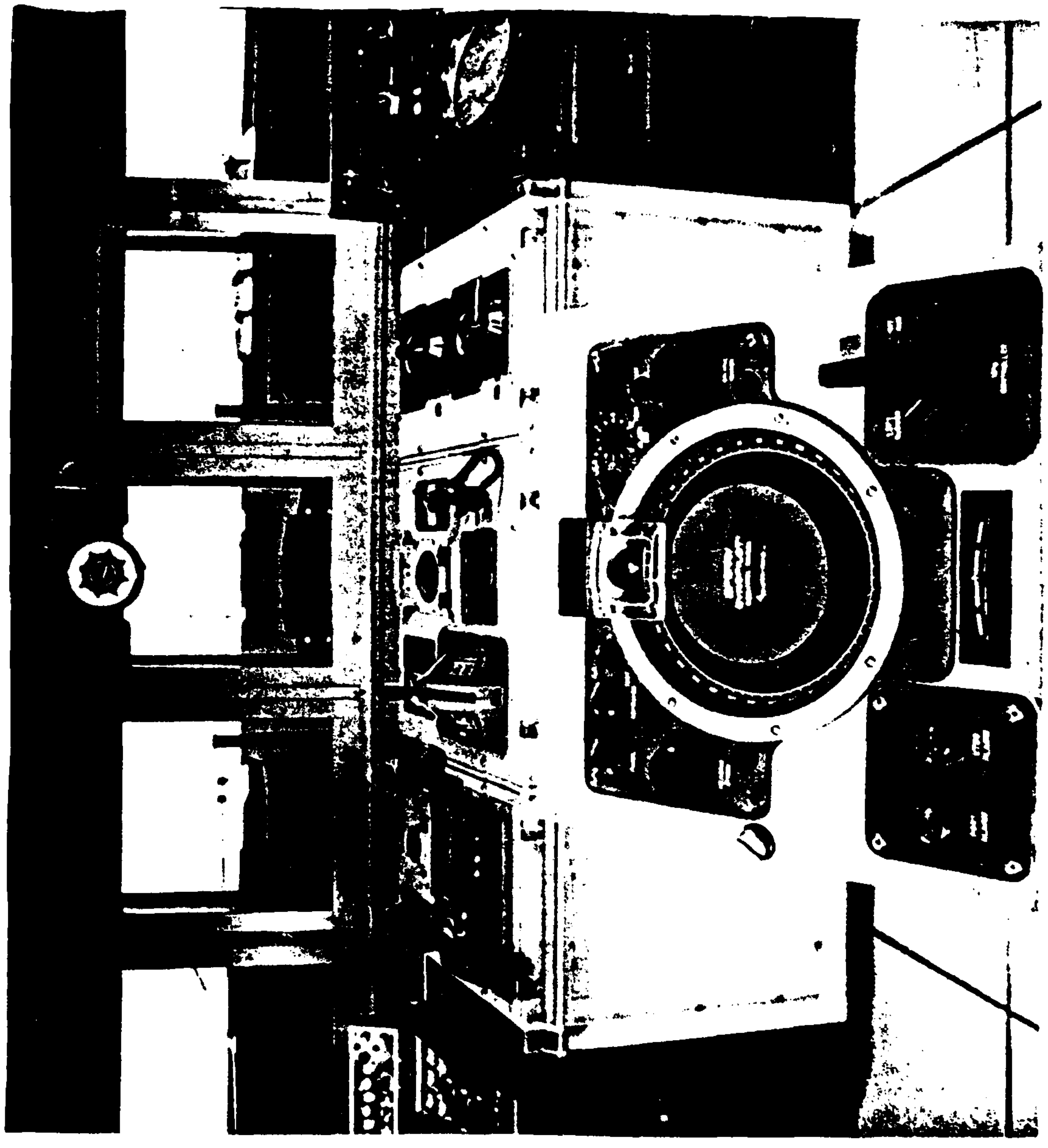
STUDENT HANDOUT

CAORF SIMULATION BRIDGE

A realistic shipboard environment is achieved in CAORF by means of a full-scale bridge with a complement of actual bridge hardware that can be found on most large contemporary merchant vessels. The flexible design of the bridge facilitates varying the equipment suite and physical arrangement, as desired.

Existing bridge instrumentation consists of:

- Relative motion and true motion radar sets for operating and displaying moving target ships and features such as navigational aids, piers, and shorelines normally found in the open sea, harbors, and docking areas
- Gyro pilot steering control stand which includes the helm unit, steering mode control, heading indicator, rate of turn indicator, rudder order, and rudder angle indicators
- Propulsion console consisting of combined engine order telegraph/throttle control, propulsion plant operating mode control, and rpm indicator
- Course and rudder angle indicator
- Bow thruster control, thruster output indicator, and status light
- Gyro repeater
- Collision avoidance system
- Various displays such as gyro repeater, rudder angle indicator, etc.
- Speed log and ship clock
- Engine order telegraph for one engine
- Engine rpm indicators for one engine
- Fathometer
- Wind speed and direction indicators
- Communications equipment including sound-powered telephone, ship intercom system, single-side-band HF radio, VHF radio, and ship whistle
- Loran C



STUDENT HANDOUT

CAORF SIMULATION
VISUAL DISPLAY

One of the unique and more extraordinary features of the CAORF simulator is the computer-generated visual imagery which simulates the outside world as seen through the bridge windows. The imagery is projected as a television picture around the bridge on a 60-foot diameter cylindrical projection screen covering a field of view 240 degrees in relative bearing and 24 degrees in elevation.

Detailed presentations in full color are provided of other ships, coastlines, buoys, bridges, buildings, piers, and other significant elements of the environment. The scene also includes ownship's forebody superimposed on the centerline of the screen. The visual scene changes in real time in accurate response to own and other ship maneuvering motions. The system is capable of displaying up to 40 moving ships on the radar from which the closest six moving ships are selected and presented in the visual scene simultaneously.

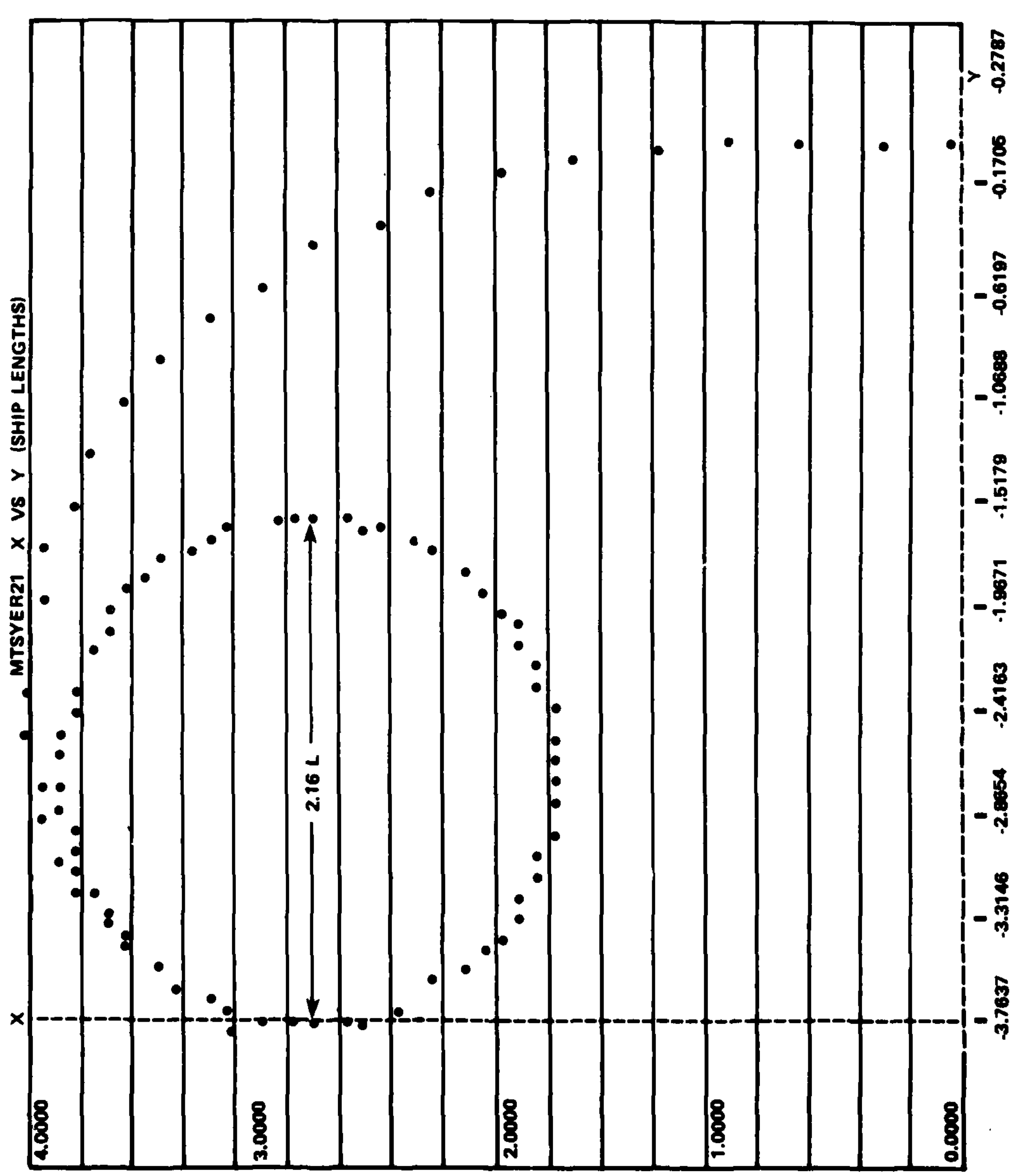
Other unique characteristics of the visual display include the ability to:

- Simulate restricted visibility conditions by altering the color intensity of an object as a function of the distance of the object from ownship, such that the color of the object approaches the color of fog or haze
- Control the illumination level so that either day or night scenes may be simulated
- Vary the relationship of the generated scene to the watchkeeper's eye height above the waterline for the particular ownship being simulated
- Change the data base to simulate any port in the world

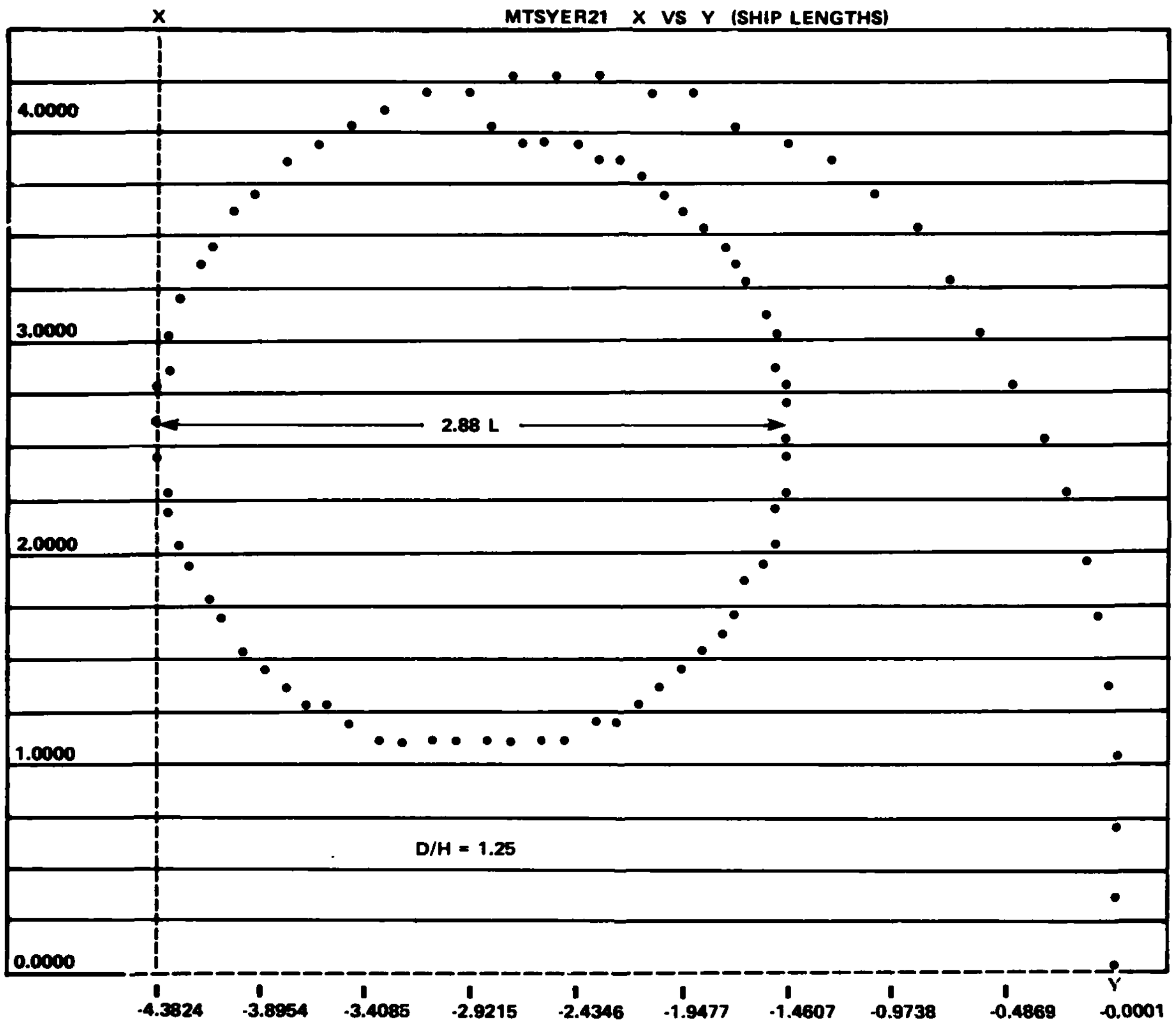
STUDENT HANDOUT

OWNSHIP CHARACTERISTICS

1. Type: 80,000 dwt tanker with superstructure aft
2. Length overall (LOA): 800 feet
3. Length between perpendiculars (LBP): 763 feet
4. Beam: 125 feet
5. Speed: forward - 0 to 18.5 knots
   astern - 0 to 9 knots
6. Propulsion: Geared steam turbine
   23,000 horsepower
   single screw
   direct pilot house control of throttle and telegraph
   variable throttle
7. Bow thruster: 2000 horsepower
8. Propeller: diameter - 23 feet
   pitch - 19 feet
9. Bridge: aft to bow - 675 feet
   forward of stern - 125 feet
10. Maximum rudder 35 degrees
11. Turning circles: deep water (see Figure)
    shallow water (see Figure)



Deepwater Turning Circle



Shallow Water Turning Circle

STUDENT HANDOUT

OWNSHIP CHARACTERISTICS (Continued)

For the purposes of this experiment, the vessel has the following characteristics:

1. Loading condition: 70 percent loaded
2. Time to go from full ahead to full astern: 180 seconds
3. Draft: 32 feet with no trim.
4. Freeboard: 20 feet at amidships
5. Height of eye at the bridge: 80 feet
6. Pivot: for turning varies as speed moves forward of midships.
7. Using throttle mode of propulsion only, the following rpm versus speed approximations:

	RPM	Ahead (Knots)	Astern (Knots)
Stop	0	0	0
Dead Slow	10	1.55	1.00
Slow	20	3.10	2.00
Half	40	6.20	4.00
Full (Maneuvering)	60	9.30	6.00
Sea Speed	90	----	9.00
Sea Speed	120	18.50	----

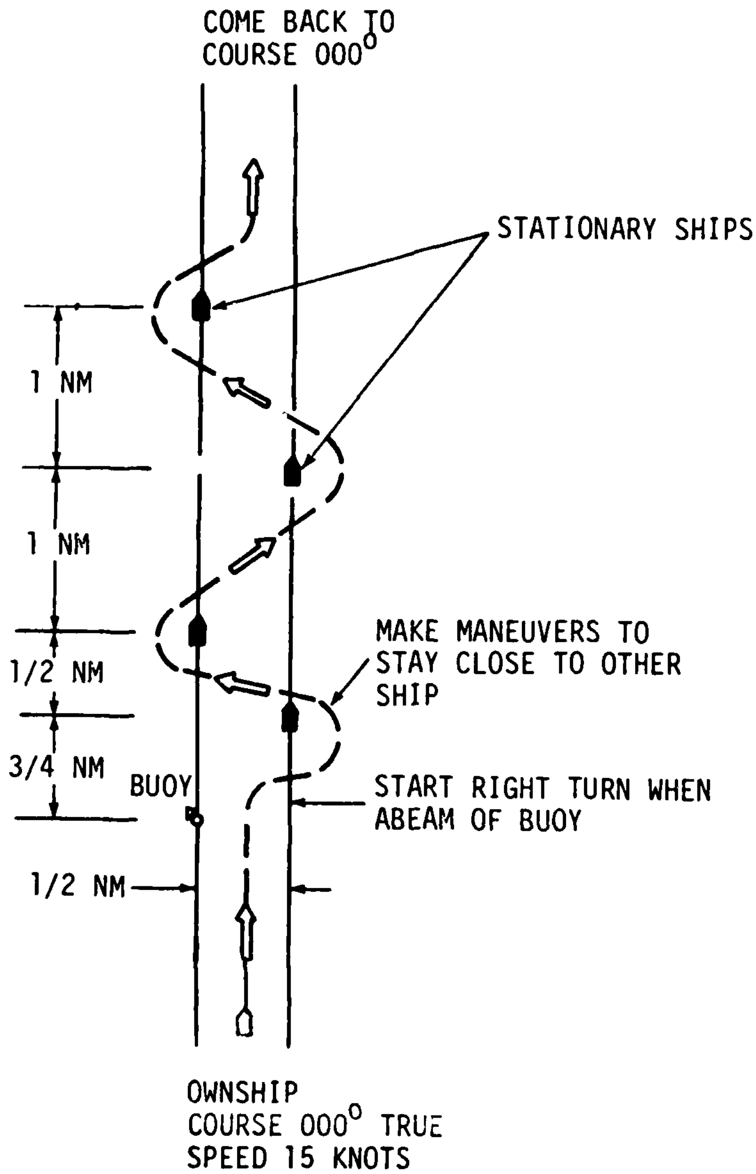


Diagram of Familiarization Scenario

STANDING ORDERS

1. Determine relative motion line of all contacts detected on radar. Confirm by visual bearing as soon as possible.

2. Notify me of any contacts which will have a CPA of 2 miles or less. This notification shall be made when the contact is not less than 10 minutes from CPA.

3. Do not maneuver the vessel without taking into consideration other contacts in the vicinity and how your maneuver will affect their CPA. It is not prudent to maneuver out of one close quarters situation only to confront another, possibly more dangerous, close quarters situation.

4. Do not hesitate to call me if you are required as stipulated above or at any time that you are in doubt as to the operations of this vessel.

1. ______________________	7. ______________________
2. ______________________	8. ______________________
3. ______________________	9. ______________________
4. ______________________	10. ______________________
5. ______________________	11. ______________________
6. ______________________	12. ______________________

SHIP'S DECK LOG

DATA SHEET

SHIP		VOYAGE NUMBER	DATE
PASSAGE (At or from)	TO		DAY OF WEEK
ZONE DESCRIPTION	CHANGED AT (Time)	TO	

HOURS	COURSE AND SPEED						STANDARD COMPASS ERROR			WEATHER OBSERVATIONS														
										WIND					TEMPERATURE			CLOUDS			WAVES		SWELL	
	RPM	GYRO READING	GYRO ERROR	TRUE HEADING	MAG STD	MAG STG	VARIATION	DEVIATION	ERROR	DIRECTION (TRUE)	SPEED (KNOTS)	VISIBILITY (MILES)	WEATHER (SYMBOLS)	BAROMETER (MILLIBARS)	DRY BULB	WET BULB	SEA WATER (IN)	AMOUNT (TENTHS)	HEIGHT (FEET)	TYPE	DIRECTION (TRUE)	HEIGHT (FEET)	DIRECTION (TRUE)	HEIGHT (FEET)
01																								
02																								
03																								
04																								
05																								
06																								
07																								
08																								
09																								
10																								
11																								
12																								
13																								
14																								
15																								
16																								
17																								
18																								
19																								
20																								
21																								
22																								
23																								
24																								

POSITION		
HOUR	LATITUDE	LONGITUDE
0000		
1200		
2000		

DRAFT		
TIME:		
FORWARD	AFT	MEAN
TIME:		
FORWARD	AFT	MEAN

LOAD LINE MARK	
ARRIVAL	
PORT	STARBOARD
DEPARTURE	
PORT	STARBOARD

NOON DATA-PREVIOUS 24 HOURS		
STEAMING TIME	DISTANCE	AVER. SPD.

TOTALS THIS VOYAGE AS OF NOON		
STEAMING TIME	DISTANCE	DIST. TO GO

SUN DATA	
SUNRISE (Time)	SUNSET (Time)

BILGE SOUNDINGS										TANK SOUNDINGS						OTHER			
BILGES OR TANKS	TIME									FP		AP				CHLKR			
		INCHES	INCHES	INCHES	INCHES	INCHES	INCHES	INCHES	INCHES	FT.	IN.	FT.	IN.	FT.	IN.	FT.	IN.	FT.	IN.
PORT	0800																		
	1600																		
STBD.	0800																		
	1600																		

PREPARED BY NAVIGATOR (Signature) | APPROVED BY MASTER (Signature)

SHIP'S LOG

REMARKS SHEET

	DAY OF WEEK	DATE

APPROVED BY MASTER (signature)

CAORF BIOGRAPHICAL QUESTIONNAIRE

(PLEASE PRINT) DATE:

NAME:

DATE OF BIRTH:

PRE-ACADEMY ADDRESS:

POST-ACADEMY ADDRESS:

PHONE NO: HOME
OFFICE

PREVIOUS EXPERIENCE

(1) Did you attend college prior to entering the Academy?

Which one?

How many years?

(2) Did you sail in the merchant marine prior to entering the Academy?

If yes, please summarize this experience including licenses, certificates, endorsements, vessels, trade routes, etc.

(3) Did you serve in the military prior to entering the Academy?

If yes, please summarize this experience including rank, rating, at-sea experience, type of vessel, etc.

SUMMARY ACADEMY RECORD

(1) What is your four-year academic average (CQPA)?

(2) What is your class standing?

(3) What was your academic average for the past quarter (QPA)?

(4) What is your major course of study?

(5) List the courses that you have taken through the Nautical Science Department while at the Academy.

(6) List your extra-curricular activities while at the Academy.

CAREER GOALS

(1) What type vessel(s) do you desire to be employed upon after graduation?

(2) What type vessel(s) do you expect to be employed upon after graduation?

(3) What company/union will you be affiliating with upon graduation?

(4) Briefly discuss your career goals within the U.S. Merchant Marine after graduation.

MIDSHIPMAN-AT-SEA TRAINING EXPERIENCE*

DATES			WATCH			GROSS		PROPULSION		MAX.
FROM	TO	POSITION	STANDER**	VESSEL NAME	VESSEL TYPE	TONS	DWT	HP	TYPE	SPEED

*Indicate time worked ashore, if applicable
**Indicate YES or NO
If any information is unknown, indicate by "UNK"

RETESTING AGREEMENT

D460: BRIDGE WATCHSTANDING (SIMULATOR-BASED TRAINING)

I hereby agree to return to CAORF, if requested by CAORF, for the purpose of retesting the Rules-of-the-Road and Port Approach Planning skills addressed in this training course. The date of this retesting will be agreeable to both parties. The approximate amount of time required for this retesting will be one (1) day. Potential intervals for retesting are 6 months after graduation and 12 months after graduation. During this retesting, I realize that I will be paid and my expenses reimbursed at the rates used by CAORF for other test subjects.

SIGNATURE:

Midshipman____________________________ Date______________

COURSE – D-460: BRIDGE WATCHSTANDING (SIMULATOR-BASED TRAINING)

STUDENT HANDOUT – CLASS II

Special Note: In addition to the items contained within, this handout will include a chart of Port International plus appropriate Coast Pilot and Light List information.

D460: Bridge Watchstanding (Simulator-Based Training)

Port Approach Planning Unit Description

The port approach planning training module will address the navigation of an 80,000 dwt tanker (loaded) into and through a restricted channel under various wind conditions. Students will be required to plan every segment of the "voyage" including: courses to steer, estimated time of arrival (ETA), effects of wind on the vessel, use of navigational aids and VHF communications. Students will then be divided into teams of three:

- Master
- Radar observer
- Navigator

Each team will have the opportunity to execute their plans on the simulator. The first plan and approach of each team will be considered the pre-training test while the last plan and approach will be considered the post-training test.

The specific issues to be addressed during the training will include:

- The approach plan
- Any necessary departure from the plan
- Shiphandling
- Current effects
- Bridge procedures

Essay Requirement Reminder

On the last day of the training course (see Course Schedule) all students will also be required to submit a typed essay (minimum 4-6 pages) on the following topic:

"A Subjective Comparison Between Midshipman Simulator-Based Training and Midshipman At-Sea Training"

This essay should concisely evaluate the role of both simulator-based training and at-sea training within the USMMA curriculum. It is suggested that the paper address one or more of the following issues:

- Advantages and disadvantages of midshipman simulator-based training and at-sea training
- Description of recommended simulator-based courses and recommended at-sea training experiences for future midshipman training
- Proper placement (i.e., semester) of recommended simulator-based training courses and at-sea training experiences within the 4-year program.

This is not a paper which requires significant research and references. It is a paper that requires careful thought about the type, quality and potential of the simulator-based training and the at-sea training that has been received, and their places within the academy program. Questions concerning this assignment should be addressed to one of the instructors.

S/S CAORF

VOYAGE ARRIVAL PLAN

PORT: ______________________________ DATE: __________ ___, 197___

COURSES

Time	Course	Required Rudder	Required RPM	Nav.Aid.	Bearing of and/or dist. off aid	Remarks

COMMUNICATIONS

Time	Position	Station Called	Channel	Remarks

SS CAORF

PRE-ARRIVAL IN PORT
CHECK-OFF LIST

PORT______________________________ DATE______________

Item	✓ or initial
1. Charts & Navigation Equipment Laid Out	
2. Binoculars in Boxes – Bell Book Ready	
3. Megaphones (Power & Hand Held) on Bridge Wings	
4. Sound Powered Phone	
5. V.H.F. Communications Inclusive of "Walkie-Talkie"	
6. Repeaters Compared With Master Gyro	
7. Ship's Whistle Tested	
8. Fathometer On	
9. Radar On	
10. Power on Deck	
11. Flags Ready	
12. Time Check ER & Bridge Clocks	
13. Anchors Ready for Letting Go	
14. Test Astern Propulsion, Bow Thruster, Steering and Remote Controls	
15. All Line Handling Stations and/or Anchor Detail Manned and Ready – Eng. Room Manned and on Standby	
16. Preparation for Pilot	

______________________________ ______________________________
MWO Master

APPENDIX D

SAMPLE INSTRUCTOR'S GUIDE

CLASSROOM EXERCISE 4 – GROUP A
CLASSROOM EXERCISE 6 – GROUP B INSTRUCTOR ____________________

Objective

The student should be able to correctly apply the rules of the road as they pertain to a crossing situation with ownship as a giveway vessel.

Methodology

Presentation
Seminar type discussion
Positive guidance

Materials

1. Coast Guard Publication CG-169
2. Transparencies
3. Case studies

Presentation

- Using the appropriate visual aids, introduce the topic – a crossing situation in which ownship is the giveway vessel.
- Reference and interpret the applicable international rules (i.e., Rules 4, 7, 8, 11, 14, 15, 16)

Seminar Type Discussion

In reference to the crossing situations depicted on the visual aids, analyze the situation with regard to:

1. Who is the giveway vessel?

2. Is a special vessel type (i.e., fishing, trawling, sailing, VLCC-constricted by draft, vessel not under command) present which would render the privileged vessel to give way?

3. In which direction should ownship maneuver?

4. When is it best to reduce speed?

5. When should action be taken? (How far away should ownship be from the traffic vessel when ownship maneuver is initiated?)

6. What types of communications should be used (whistle signals, radio communications)?

7. What is the closing rate?

8. How do vessel maneuvering characteristics (both ownship and traffic vessel) influence ownship's decision of when to maneuver?

- Vessel type
- Head reach
- Advance and transfer
- Tactical diameter
- Final diameter
- Drift angle

Positive Guidance

Using a case study or representative crossing situation, discuss the proper maneuvering technique that ownship (as giveway vessel) should employ. Stress maneuvering early (i.e., 5 to 7 nm), substantially (i.e., 10-degree course change), and achieving a CPA of at least 1 nm with all vessels.

Associated Scenarios (Presimulation Plan – Appendix A)

Scenarios 9, 10, and 11

SIMULATOR EXERCISE 4 – GROUP A
SIMULATOR EXERCISE 6 – GROUP B
INSTRUCTOR ____________________

Objective

The midshipman should properly apply the rules of the road and take appropriate action in maneuvering ownship when it is the giveway vessel in a crossing situation.

Methodology

- Instructor description of scenario
- Student hands-on training
- Instructor commentary evaluation
- Postproblem critique

Scenarios (Presimulation Plan – Appendix A)

Scenarios 9, 10, and 11

Instructor Description of Scenario

Prior to each training scenario, the instructor will provide the students with the following information:

- Ownship course and speed
- Traffic vessel locations from ownship
- Traffic vessel course and speed
- Wind, sea, and visibility conditions

Students' Hands-on Training

Students within an experimental group will be assigned to two bridge teams (each having a senior watch officer, radar observer, and navigator). These teams will alternate on successive scenarios between (a) hand-on training and (b) observation from the human factors station. Within each bridge team, the students will rotate assignments after each of their hands-on scenarios.

Instructor Commentary Evaluation

During each scenario, the instructor will provide the three students at the human factors station with a commentary evaluation of the unfolding scenario, including a discussion of the proper maneuvers to avoid a potential collision situation. The instructor will utilize the Student Evaluation Sheet (Appendix E) as a guide for this evaluation.

Postproblem Critique

Upon the completion of each scenario, the instructor will verbally evaluate the scenario, discussing the proper maneuvers to avoid a potential collision situation. The instructor will then give a description of the next scenario.

APPENDIX E

MANUAL DATA COLLECTION SHEETS

ROR STUDENT EVALUATION SHEET

The attached form will be used by one of the two instructors to subjectively evaluate student performance on the ROR pretest and ROR posttest. The same instructor will evaluate each student in the training program for both the ROR pretest and the ROR posttest. The second instructor may be used to evaluate the Port Approach Planning test scenarios later in the course.

ROR STUDENT EVALUATION SHEET

NAME________________________________ DATE____________________

PBT No. ____ Run No.__________ Pretest
Posttest

Grading & Checkoff List (Score 0 - 10)

1.	Determination of Greatest Threat	________
2.	Determination of Relative Motion Line	________
3.	Compliance With Standing & Night Orders	________
4.	Proper Use of VHF Communications	________
5.	Calculation of CPA & Speed Triangle	________
6.	Maneuvering - Time and Range	________
6a.	Maneuvering Magnitude of Rudder & Speed Changes	________
7.	Achieving of Planned CPA	________
8.	Result of Maneuver	________
9.	Team Coordination	________
10.	Senior Watch Officer's Composure	________
11.	Proper Wheel Commands	________
12.	Proper Commands to Team	________

TOTAL SCORE ________

Comments:

____
Instructor/Evaluator

ROR HUMAN FACTORS DATA SHEET

The attached form will be used by the CAORF observer to record the specified information for each student's ROR pretest and ROR posttest. The same CAORF observer should be employed for all ROR test scenarios. The information to be recorded will be as follows:

Bridge Time - The time of a command or the start/completion time of a task or other notable action as measured by the bridge clock to the nearest second.

Commands - Any orders or instructions issued by the test subject, and any responses to same. Helm and engine orders should be recorded. However, normal helmsman responses should be excluded. Particular care should be taken to note (1) requests to the radar observer and responses from same and (2) information passed to the master and responses from same.

Task - The following tasks when executed by the test subject should be recorded with a start and stop time:

- Visual Bearing
- Binocular Effect
- Radar Observations

Comments - Any amplifying information.

ROR HUMAN FACTORS DATA SHEET

Name ______________________ Date ______________________

Radar Observer ______________ CAORF Observer ___________

Helmsman __________________ PBT No.___ Run No.____

*NOTE: See Instruction Sheet

Pretest
Posttest

Bridge Time	Commands*	Tasks*	Comments

ROR HUMAN FACTORS DATA SHEET

Continuation Sheet: PBT No.___ Run No. ___

Bridge Time	Commands*	Tasks*	Comments

PORT APPROACH HUMAN FACTORS DATA SHEET

The attached form will be used by the CAORF observer to record the specified information for each student team's Port Approach pretest and Port Approach posttest. The same CAORF observer should be employed for all Port Approach test scenarios. The information to be recorded will be as follows:

Bridge Time - The time of a command or the start/completion time of a task or other notable action as measured by the bridge clock to the nearest second.

Commands - Any orders or instructions issued by the master or navigator, and any responses to same. Helm and engine orders should be recorded. However, normal helmsman responses should be excluded. Particular care should be taken to note requests to the radar observer and responses from same.

Task - The following tasks when executed by the senior watch officer or navigator should be recorded with a start and stop time:

- Visual Bearing
- Radar Observations

Comments - Any amplifying information

PORT APPROACH HUMAN FACTORS DATA SHEET

Master ____________________ Date ____________________

Radar Observer ____________________ CAORF Observer ____________________

Helmsman ____________________ PBT No.____ Run No.____

Pretest

*NOTE: See Instruction Sheet

Posttest

Bridge Time	Commands*	Tasks*	Comments

PORT APPROACH HUMAN FACTORS DATA SHEET

Continuation Sheet: PBT No.___ Run No.___

Bridge Time	Commands*	Tasks*	Comments

PORT APPROACH STUDENT EVALUATION SHEET

The attached form will be used by one of the two instructors to subjectively evaluate student performance on the Port Approach Planning pretest and the Port Approach Planning posttest. The same instructor will evaluate each student in the training program for both the Port Approach Planning pretest and the Port Approach Planning posttest. The second instructor may be used to evaluate the rules-of-the-road test sceanrios earlier in the course.

PORT APPROACH STUDENT EVALUATION SHEET

Senior Watch Officer__________ Date__________

Navigator____________________ Pretest

Radar Observer_______________ Posttest

PBT No._____Run No._______

Grading and Checkoff List (Score 0 -10)

1. Evaluation of Bridge Team Port Approach Plan __________
2. Completion of Pre Arrival Check List __________
3. Compliance With Port Regulations __________
4. Proper VHF Communications Procedures
   - Pilot Station __________
   - CG Vessel Traffic System __________
5. Timely Identification of Range Line __________
6. Deviation From Range Line __________
7. Proper Use of Turn Bearing (Turn 1) __________
8. Deviation From Projected Track (Leg 2) __________
9. Proper Use of Turn Bearing (Turn 2) __________
10. Deviation From Projected Track (Leg 3) __________
11. Proper Use of Turn Bearing (Turn 3) __________
12. Deviation From ETA at Pilot Station __________
13. Completeness, accuracy, & neatness of navigation plot __________
14. Senior Watch Officer's Composure __________
15. Proper Wheel Commands __________
16. Proper Communications Within Team __________

TOTAL SCORE __________

Comments:

____
Instructor/Evaluator

APPENDIX F

RESULTS: RULES OF THE ROAD

This appendix presents the written test results as well as the results of the cadets' simulator performance on the rules of the road module related skills. The results describe the cadet input characteristics and the program's training effectiveness based on data from both groups of cadets, thus yielding a sample size of twelve. Also presented are the results of a between-group posttest comparison; that is, the posttest data resulting from the performance of the six cadets trained with the 120-degree field of view is compared with the posttest data resulting from the performance of the six cadets trained with the 240-degree field of view.

Table F-1 presents the cadet input characteristics; that is, it describes the proficiency levels of cadet rules of the road related skills prior to the simulator-based training program. The mean value, the standard deviation, and any comments are specified for each of the applicable 18 performance measures.

Table F-2 presents the data which describe the program's training effectiveness; that is, the change in proficiency levels of cadet skills as a result of the simulator-based training program's rules of the road module. The mean value and standard deviation on both the pretest and the posttest, the t-test* results, and any comments are specified for each of the applicable 18 performance measures.

Table F-3 presents the posttest comparison data; that is it contrasts the proficiency levels of the cadets trained with the 120-degree field of view with the proficiency levels of the cadets trained with the 240-degree field of view. For each of the two groups, the mean value and standard deviation on the posttest, the t-test results, and any comments are specified for each of the applicable 18 performance measures.

*A t-test is a difference of means test, i.e., a test for the probability (p) that the mean of an experimental group differed from the mean of another merely by sampling error.

TABLE F-1. PHASE 3, CADET INPUT CHARACTERISTICS (n = 12 CADETS)

Performance Measure	Mean	Standard Deviation	Comments
CPA (nm)	0.87	0.73	--
Collisions	--	--	No collisions
Range of maneuver (nm)	2.34	1.06	--
Magnitude of course change (degrees)	50.8	20.6	--
Number of course orders	2.49	1.50	--
Number of rudder orders	3.66	3.87	--
Number of engine orders	1.67	2.27	--
Master notified	--	--	75 percent (9/12)
Range master notified (nm)	3.52	1.39	--
VHF communications	--	--	58 percent (7/12)
Range VHF communications (nm)	3.13	1.31	--
Number of visual bearings	1.25	2.09	--
Number of radar requests	3.33	0.98	--
Number of binocular requests	3.25	1.42	--
Instructor evaluation	65.8	9.50	--
Written rules of the road test	67.6	11.6	--
Written radar test	75.1	10.5	--
Written shiphandling test	70.3	6.90	--

TABLE F-2. PHASE 3. TRAINING EFFECTIVENESS (n = 12 CADETS)

Performance Measure	Pretest		Posttest		t-test	Comments
	Mean Value	Standard Deviation	Mean Value	Standard Deviation		
CPA (nm)	0.97	0.73	1.86	0.69	$t=3.27$; $p \leq 0.005$*	--
Collisions						Pre - no collisions Post - no collisions
Range of maneuver (nm)	2.34	1.06	3.32	0.64	$t=2.62$; $p \leq 0.005$	--
Magnitude of course change (degrees)	50.8	20.6	54.4	25.3	$t=0.37$ NS	--
Number of course orders	2.49	1.50	2.66	1.50	$t=0.26$; NS	--
Number of rudder orders	3.66	3.87	3.16	1.27	$t=0.47$; NS	--
Number of engine orders	1.67	2.27	0.58	1.08	$t=1.44$ $p \leq 0.10$	--
Master notified	--	--	--	--	--	Pre - 75% (9/12) Post - 100% (12/12)
Range master notified (nm)	3.52	1.39	3.86	0.88	$t=0.68$; NS	--
VHF communications	--	--	--	--	--	Pre - 58% (7/12) Post - 100% (12/12
Range VHF communications (nm)	3.13	1.31	4.76	0.73	$t=3.60$; $p \leq 0.005$	--

*p = probability

TABLE F-2. PHASE 3. TRAINING EFFECTIVENESS (n = 12 CADETS) (Continued)

Performance Measure	Pretest		Posttest		t-test	Comments
	Mean Value	Standard Deviation	Mean Value	Standard Deviation		
Number of visual bearings	1.25	2.09	5.91	3.77	$t=3.59$; $p<0.005$	--
Number of radar requests	3.33	0.98	1.33	0.49	$t=6.05$; $p<0.0005$	--
Number of binocular requests	3.25	1.42	2.33	1.37	$t=1.55$; $p<0.10$	--
Instructor evaluation	65.8	9.5	105.9	4.30	$t=12.7$; $p<0.0005$	--
Written rules of the road test	67.6	11.6	79.7	9.60	$t=2.67$; $p<0.01$	--
Written radar test	75.1	10.5	84.0	7.10	$t=2.33$; $p<0.025$	--
Written shiphandling test	70.3	6.90	86.3	5.30	$t=6.10$; $p<0.0005$	--

TABLE F-3. PHASE 3, POSTTEST COMPARISONS AFTER TRAINING UNDER 240- AND 120-DEGREE HORIZONTAL FIELD OF VIEW (n = 6 CADETS)

Performance Measure	240-Degree Field of View		120-Degree Field of View		t-test	Comments
	Mean Value	Standard Deviation	Mean Value	Standard Deviation		
CPA (nm)	1.86	0.64	1.86	0.81	t=0.00; NS	--
Collisions	--	--	--	--	--	240° - no collisions 120° - no collisions
Range of maneuver (nm)	3.21	0.52	3.43	0.77	t=0.529; NS	--
Magnitude of course change (degrees)	45.0	17.3	57.5	29.6	t=0.82; NS	--
Number of course orders	2.33	1.51	3.00	1.55	t=0.69; NS	--
Number of rudder orders	3.16	1.47	3.16	1.17	t=0.00; NS	--
Number of engine orders	1.66	1.33	0.00	0.00	t=2.79; $p \leq 0.01$	--
Master notified	--	--	--	--	--	240° - 100% (6/6) 120° - 100% (6/6)
Range master notified (nm)	3.66	0.71	4.05	1.05	t=0.68; NS	--
VHF communications	--	--	--	--	--	240° - 100% (6/6) 120° - 100% (6/6)
Range VHF communications (nm)	4.50	0.62	5.03	0.80	t=1.17; NS	--

TABLE F-3. PHASE 3, POSTTEST COMPARISONS AFTER TRAINING UNDER 240 AND 120-DEGREE HORIZONTAL FIELD OF VIEW (*n* = 6 CADETS) (Continued)

Performance Measure	240-Degree Field of View		120-Degree Field of View		t-test	Comments
	Mean Value	Standard Deviation	Mean Value	Standard Deviation		
Number of visual bearings	8.00	4.29	3.83	1.60	$t=2.04$; $p<0.05$	--
Number of radar requests	1.33	0.52	1.33	0.57	$t=0.00$; NS	--
Number of binocular requests	2.16	0.75	2.50	1.87	$t=0.38$; NS	--
Instructor evaluation	105.16	6.11	106.66	1.50	$t=0.53$; NS	--
Written rules of the road test	78.66	10.01	80.66	9.93	$t=0.32$; NS	--
Written radar test	82.66	7.81	85.33	6.71	$t=0.58$; NS	--
Written shiphandling test	84.66	5.88	88.00	4.38	$t=1.02$; NS	--

APPENDIX G

RESULTS: PORT APPROACH

This appendix presents the results of the cadets' simulator performance on the port approach module related skills. The results describe the cadet input characteristics and the program's training effectiveness based on data from all four subgroups of cadets, thus yielding a sample size of four. Also presented is the training effectiveness data for each individual group, that is, the training effectiveness data for Kings Point Group A (240-degree F/V) and data for Kings Point Group B (120-degree F/V).

Table G-1 presents the cadet input characteristics; that is, it describes the proficiency levels of the cadets' port approach related skills prior to the simulator-based training program. The mean value, the standard deviation, and any comments are specified for each of the applicable 21 performance measures.

Table G-2 presents the overall training effectiveness scores based on the combined results of all four subgroups; that is, it describes the overall change in proficiency levels of cadet skills as a result of the simulator-based training programs port approach module. The mean value and standard deviation on the pretest and the posttest, the t-test results, and any comments are specified for each of the applicable 21 performance measures.

Table G-3 presents the training effectiveness data for the Kings Point Group A cadets trained with the 240-degree field of view. The pretest and posttest data for each subgroup of Group A as well as the average pretest and posttest scores for each performance are presented. Also the training effectiveness score derived by subtracting the average posttest score from the average pretest score is given.

Table G-4 presents the training effectiveness data for the Kings Point Group B cadets trained with the 120-degree field of view. The pretest and posttest data for each subgroup of Group B as well as the average pretest and posttest scores for each performance are presented. Also the training effectiveness score derived by subtracting the average posttest score from the average pretest score is given.

TABLE G-1. PHASE 3, CADET INPUT CHARACTERISTICS
(n = 4 CADET BRIDGE TEAMS)

Performance Measure	Mean Value	Standard Deviation	Comments
Channel excursions			
Leg 1	--	--	100% - No
Leg 2	--	--	75% - No
Leg 3	--	--	50% - No
Leg 4	--	--	50% - No
Turn 1			
Rudder order (actual)	21.7°	2.9	--
Initial range offset (feet)	712.5	295.5	
Leg 1			
Maximum track deviation (feet)	861.5	181.6	--
Navigation fix accuracy (feet)	930.6	41.4	
Turn 2			
Rudder order (actual)	13.8°	4.8	--
Initial centerline offset (feet)	880.0	611.2	
Leg 2			
Maximum track deviation (feet)	880.0	611.2	--
Navigation fix accuracy (feet)	1088.9	362.2	
Turn 3			
Rudder order (actual)	15.0	5.0	--
Initial centerline offset (feet)	875.0	427.2	
Leg 3			
Maximum track deviation (feet)	1582.5	1214.0	--
Navigation fix accuracy (feet)	1235.0	593.7	
Turn 4			
Rudder order (actual)	15.0	7.1	--
Initial centerline offset	1102.5	733.7	
Number of course orders	11.0	2.2	--
Number of rudder orders	11.2	7.1	--
Number of engine orders	1.8	1.3	--
Number of fixes	14.8	3.4	--
Instructor evaluation	104.5	9.5	--
ETA deviation (min)	2.3	1.0	--

TABLE G-2. PHASE 3, CADET TRAINING EFFECTIVENESS (n = 4 CADET BRIDGE TEAMS)

Performance Measure	Pretest Mean Value	Pretest Standard Deviation	Posttest Mean Value	Posttest Standard Deviation	t-test	Comments
Channel excursions	--	--	--	--	--	Pre / Post
Leg 1	--	--	--	--	--	100% No / 100% No
Leg 2	--	--	--	--	--	75% No / 100% No
Leg 3	--	--	--	--	--	50% No / 75% No
Leg 4	--	--	--	--	--	50% No / 50% No
Turn 1						
Rudder order (actual)	21.7°	2.9	15.0°	7.1	$t=1.51$; $p<0.10$	--
Initial range offset (feet)	712.5	295.5	500.0	195.8	$t=1.11$; NS*	--
Leg 1						
Maximum track deviation (feet)	861.5	181.6	550.0	177.9	$t=2.12$; $p<0.05$	--
Navigation fix accuracy (feet)	930.6	41.4	778.3	372.4	$t=0.70$; NS	--
Turn 2						
Rudder order (actual)	13.8°	4.8	16.25°	4.8	$t=0.63$; NS	--
Initial centerline offset (feet)	880.0	611.2	587.5	143.6	$t=0.81$; NS	--
Leg 2						
Maximum track deviation (feet)	880.0	611.2	612.5	165.2	$t=0.73$; NS	--
Navigation fix accuracy (feet)	1088.9	362.2	1252.2	899.9	$t=0.29$; NS	--

*NS = not significant

TABLE G-2. PHASE 3, CADET TRAINING EFFECTIVENESS (n = 4 CADET BRIDGE TEAMS) (Continued)

Performance Measure	Pretest		Posttest		t-test	Comments
	Mean Value	Standard Deviation	Mean Value	Standard Deviation		
Turn 3						
Rudder order (actual)	15.0	5.0	16.25	2.5	t=0.39; NS	--
Initial centerline offset (feet)	875.0	427.2	366.7	225.5	t=1.82; $p < 0.10$	--
Leg 3						
Maximum track deviation (feet)	1582.5	1214.0	1787.5	2619.2	t=0.12; NS	--
Navigation fix accuracy (feet)	1235.0	593.7	682.2	190.5	t=1.54; $p < 0.10$	--
Turn 4						
Rudder order (actual)	15.0	7.1	20.0	5.0	t=0.99; NS	--
Initial centerline offset (feet)	1102.5	733.7	1387.5	165.2	t=0.66; NS	--
Number of course orders	11.0	2.2	13.8	6.8	t=0.68; NS	--
Number of rudder orders	11.2	7.1	7.5	3.4	t=0.81; NS	--
Number of engine orders	1.8	1.3	3.0	2.7	t=0.70; NS	--
Number of fixes	14.8	3.4	14.0	3.0	t=0.31; NS	--
Instructor evaluation	104.5	9.5	114.6	16.6	t=0.91; NS	--
ETA deviation	2.3	1.0	3.75	2.5	t=0.93; NS	--

TABLE G-3. TRAINING EFFECTIVENESS: KINGS POINT GROUP A (240°)

Performance Measure	Pretest	Posttest	Training Effectiveness (Posttest Minus Pretest)
Channel excursion	50% No (1) = yes (2) = no	100% Yes (1) = yes (2) = yes	+50% (1) = no change (2) = -100%
Turn 1:			
Rudder order deviation (planned/actual)	25°R/NA (1) = 20°R/NA (2) = 30°R/20°R	17.5°R/17.5°R (1) = 15°R/15°R (2) = 20°R/20°R	-7.5°R/NA (1) = -5°R/NA (2) = -10°R/0°
Initial range offset	950 feet (L) (1) = 900 feet (L) (2) = 1000 feet (L)	525 feet (L) (1) = 300 feet (L) (2) = 750 feet (L)	-425 feet (L) (1) = -600 feet (L) (2) = -250 feet (L)
Leg 1			
Maximum track deviation	950 feet (1) = 900 feet (2) = 1000 feet (R)	575 feet (L) (1) = 400 feet (L) (2) = 750 feet (L)	-375 feet (1) = -500 feet (2) = -250 feet
Navigation fix accuracy	915.63 feet (1) = 912.5 feet (2) = 918.75 feet	NA (1) = NA (2) = 566.67 feet	NA (1) = NA (2) = -352.08
Turn 2			
Rudder order deviation (planned/actual)	NA/10°L (1) = NA/10°L (2) = 30°L/10°L	20°L/17.5°L (1) = 25°L/20°L (2) = 15°L/15°L	NA/+7.5°L (1) = NA/+10°L (2) = -15°L/5°L
Initial centerline offset	1310 feet (1) = 1720 feet (R) (2) = 900 feet (L)	756 feet (L) (1) = 750 feet (L) (2) = 600 feet (L)	-635 feet (1) = -970 feet (2) = -300 feet (L)

TABLE G-3. TRAINING EFFECTIVENESS: KINGS POINT GROUP A (240°) (Continued)

Performance Measure	Pretest	Posttest	Training Effectiveness (Posttest Minus Pretest)
Leg 2			
Maximum track deviation	1310 feet (1) = 1720 feet (2) = 900 feet (L)	725 feet (L) (1) = 800 feet (L) (2) = 650 feet (L)	-585 feet (1) = -920 feet (2) = -250 feet (L)
Navigation fix accuracy	NA (1) = NA (2) = 816.67 feet	NA (1) = NA (2) = 940 feet	NA (1) = NA (2) = +123.33 feet
Turn 3			
Rudder order deviation (planned/actual)	NA (1) = NA/15°L (2) = 30°L/NA	20°L/17.5°L (1) = 25°L/20°L (2) = 15°L/15°L	NA (1) = NA/5°L (2) = -15°L/NA
Initial centerline offset	700 feet (1) = 800 feet (R) (2) = 600 feet (L)	250 feet (L) (1) = 150 feet (L) (2) = 350 feet (L)	-450 feet (1) = -650 feet (2) -250 feet (L)
Leg 3			
Maximum track deviation	1900 feet (L) (1) = 3200 feet (L) (2) = 600 feet (L)	425 feet (L) (1) = 150 feet (L) (2) = 700 feet (L)	-1475 feet (L) (1) = -3050 feet (L) (2) = +100 feet (L)
Navigation fix accuracy	1175 feet (1) = 1500 feet (2) = 850 feet	NA (1) = NA (2) = 666.67 feet	NA (1) = NA (2) = -183.33 feet

TABLE G-3. TRAINING EFFECTIVENESS: KINGS POINT GROUP A (240°) (Continued)

Performance Measure	Pretest	Posttest	Training Effectiveness (Posttest Minus Pretest)
Turn 4			
Rudder order deviation (planned/actual)	NA (1) = NA/10°L (2) = 30°R/15°R	22.5°R/20°R (1) = 20°R/15°R (2) = 25°R/25°R	NA (1) = NA (2) = -5°R/+10°R
Initial centerline offset	775 feet (L) (1) = 1000 feet (L) (2) = 550 feet (L)	1375 feet (L) (1) = 1400 feet (L) (2) = 1350 feet (L)	600 feet (L) (1) = +400 feet (L) (2) = +800 feet (L)
Number of course orders	9.5 (1) = 10 (2) = 9	10.5 (1) = 10 (2) = 11	1 (1) = 0 (2) = +2
Number of rudder orders	13 (1) = 21 (2) = 5	6 (1) = 8 (2) = 4	-7 (1) = -13 (2) = -1
Number of engine orders	2 (1) = 2 (2) = 2	4.5 (1) = 2 (2) = 7	+2.5 (1) = 0 (2) = 5
Number of fixes	17 (1) = 18 (2) = 16	NA (1) = NA (2) = 17	NA (1) = NA (2) = 1

TABLE G-3. TRAINING EFFECTIVENESS: KINGS POINT GROUP A (240°) (Continued)

Performance Measure	Pretest	Posttest	Training Effectiveness (Posttest Minus Pretest)
Instructor evaluation	103.5 (1) = 97 (2) = 110	121.25 (1) = 123.5 (2) = 119	+17.75 (1) = +26.5 (2) = +9
ETA (planned/actual)	0915/0912 (1) = 0915/0912 (2) = 0915/0912	0915/0914.5 (1) = 0915/0911 (2) = 0915/0918	0/+2.5 (1) = 0/-1 (2) = 0/+6

TABLE G-4. TRAINING EFFECTIVENESS: KINGS POINT GROUP B (120°)

Performance Measure	Pretest	Posttest	Training Effectiveness (Posttest Minus Pretest)
Channel excursion	50% - No (1) = Yes (2) = No	50% - No (1) = Yes (2) = No	No change (1) = No change (2) = No change
Turn 1			
Rudder order deviation (planned/actual)	NA/22.5°R (1) = NA/25°R (2) = NA/20°R	20°R/12.5°R (1) = 20°R/20°R (2) = 20°R/5°R	NA/-10°R (1) = NA/-5°R (2) = NA/-15°R
Initial range offset	475 feet (1) = 350 feet (R) (2) = 600 feet (L)	475 feet (L) (1) = 550 feet (L) (2) = 400 feet (L)	0 feet (1) = 200 feet (2) = -200 feet (L)
Leg 1			
Maximum track deviation	773 feet (1) = 596 feet (2) = 950 feet	525 feet (L) (1) = 650 feet (L) (2) = 400 feet (L)	-248 feet (1) = 54 feet (2) = -550 feet
Navigation fix accuracy	945.835 feet (1) = 991.67 feet (2) = 900 feet	884.165 feet (1) = 1208.33 feet (2) = 560 feet	-61.67 feet (1) = 216.66 feet (2) = -340 feet
Turn 2			
Rudder order deviation (planned/actual)	NA/17.5°L (1) = NA/20°L (2) = NA/15°L	20°L/15°L (1) = 25°L/10°L (2) = 15°L/20°L	NA/-2.5°L (1) = NA/-10°L (2) = NA/5°L
Initial centerline offset	450 feet (1) = 600 feet (R) (2) = 300 feet (L)	500 feet (L) (1) = 400 feet (L) (2) = 600 feet (L)	50 feet (1) = -200 feet (2) = 300 feet

TABLE G-4. TRAINING EFFECTIVENESS: KINGS POINT GROUP B (120°) (Continued)

Performance Measure	Pretest	Posttest	Training Effectiveness (Posttest Minus Pretest)
Leg 2			
Maximum track deviation	450 feet (1) = 600 feet (2) = 300 feet	500 feet (1) = 400 feet (L) (2) = 600 feet (L)	50 feet (1) = -200 feet (2) = 300 feet
Navigation fix accuracy	1225 feet (1) = 1500 feet (2) = 950 feet	1408.335 feet (1) = 2266.67 feet (2) = 550 feet	183.335 feet (1) = 766.67 feet (2) = -400 feet
Turn 3			
Rudder order deviation (planned/actual)	NA/15°L (1) = NA/20°L (2) = NA/10°L	17.5°L/15°L (1) = 20°L/15°L (2) = 15°L/15°L	NA/0° (1) = NA/-5°L (2) = NA/5°L
Initial centerline offset	1050 feet (R) (1) = 1500 feet (R) (2) = 600 feet (R)	1350 feet (1) = 2100 feet (R) (2) = 600 feet (L)	300 feet (1) = 600 feet (R) (2) = 0 feet
Leg 3			
Maximum track deviation	1265 feet (1) = 1830 feet (2) = 700 feet	3150 feet (1) = 5700 feet (R) (2) = 600 feet (L)	1885 feet (1) = 3870 feet (2) = -100 feet
Navigation fix accuracy	1295 feet (1) = 1940 feet (2) = 650 feet	690 feet (1) = 880 feet (2) = 500 feet	-605 feet (1) = -1060 feet (2) = -150 feet

TABLE G-4. TRAINING EFFECTIVENESS: KINGS POINT GROUP B (120°) (Continued)

Performance Measure	Pretest	Posttest	Training Effectiveness (Posttest Minus Pretest)
Turn 4			
Rudder order deviation (planned/actual)	NA/17.5° (1) = NA/25°R (2) = NA/10°R	20°R/NA (1) = 20°R/NA (2) = 20°R/20°R	NA (1) = NA (2) = NA/10°R
Initial centerline offset	1525 feet (L) (1) = 2100 feet (L) (2) = 950 feet (L)	1400 feet (L) (1) = 1600 feet (L) (2) = 1200 feet (L)	-125 feet (L) (1) = -500 feet (L) (2) = 250 feet (L)
Number of course orders	12.5 (1) = 11 (2) = 14	17 (1) = 24 (2) = 10	4.5 (1) = 13 (2) = -4
Number of rudder orders	9.5 (1) = 7 (2) = 12	9 (1) = 12 (2) = 6	-0.5 (1) = 5 (2) = -6
Number of engine orders	1.5 (1) = 0 (2) = 3	1.5 (1) = 1 (2) = 2	0 (1) = 1 (2) = -1
Number of fixes	12.5 (1) = 10 (2) = 15	12.5 (1) = 14 (2) = 11	0 (1) = 4 (2) = -4
Instructor evaluation	105.5 (1) = 96 (2) = 115	108 (1) = 90 (2) = 126	2.5 (1) = -6 (2) = 11
ETA (planned/actual)	0914/0915.5 (1) = 0914/0916 (2) = 0914/0915	0915/0919 (1) = 0915/0922 (2) = 0915/0916	1/3.5 (1) = 1/6 (2) = 1/1

APPENDIX H

STUDENT DEBRIEFING QUESTIONNAIRE

Course — D460: Bridge Watchstanding (Simulator-based Training)

The attached form will be administered to the students by the instructor on the last day of the course after the completion of the Port Approach posttest. Students will individually answer the questions on the form and return sam eto the instructor prior to departing CAORF.

STUDENT DEBRIEFING QUESTIONNAIRE

Name:______________________________ Date:______________

I. SELF EVALUATION

(1) Rank your performance on the Rules-of-the-Road pretest (0 to 10):

0 1 2 3 4 5 6 7 8 9 10
Poor Excellent

(2) Rank your performance on the Rules-of-the-Road posttest (0 to 10):

0 1 2 3 4 5 6 7 8 9 10
Poor Excellent

(3) Rank your team's performance on the Port Approach pretest (0 to 10):

0 1 2 3 4 5 6 7 8 9 10
Poor Excellent

(4) Rank your team's performance on the Port Approach posttest (0 to 10):

0 1 2 3 4 5 6 7 8 9 10
Poor Excellent

II. SIMULATOR COMMENTS

(5) Rank the realism of the simulated visual scene during the Rules-of-the-Road training scenarios:

0 1 2 3 4 5 6 7 8 9 10
Poor Excellent

(6) Rank the realism of the simulated visual scene during the Port Approach training scenarios:

0 1 2 3 4 5 6 7 8 9 10
Poor Excellent

(7) Was the simulated visual scene adequate for the Rules-of-the-Road training module?

Comments:

(8) Was the simulated visual scene adequate for the Port Approach training module?

Comments:

(9) Did the "Binocular Effect" detract significantly from overall simulator realism?

Comments:

III. TRAINING PROGRAM COMMENTS

(10) Compare the practical value of this course to the practical value of other courses presented by the Nautical Science Department:

This course more valuable ☐

This course equivalent value ☐

This course less valuable ☐

Comments:

(11) Compare the practical value of this course to the practical value of your last at-sea training period:

This course more valuable ☐

This course equivalent value ☐

This course less valuable ☐

Comments:

(12) From which training module did you gain the most practical experience:

Rules-of-the-Road ☐

Port Approach ☐

Comments:

(13) Evaluate the length of the classroom sessions:

Too long ☐

About right ☐

Too short ☐

Comments:

(14) Evaluate the length of the simulator sessions:

Too long ☐

About right ☐

Too short ☐

Comments:

(15) Rank the overall training program organization (0 to 10):

0 1 2 3 4 5 6 7 8 9 10

Poor Excellent

(16) Rank the professionalism of the instructors;

0 1 2 3 4 5 6 7 8 9 10

Poor Excellent

IV. LOGISTICAL COMMENTS

(17) Did you have adequate familiarization on the simulator prior to the Rules-of-the-Road pretest?

Comments:

(18) Did the hours at which this course was offered create significant problems for you?

Comments:

(19) Will you recommend this course to your friends?

Comments:

(20) Will you participate in future CAORF experiments if your expenses are reimbursed?

Comments:

V. PRACTICAL EXPERIENCE COMMENTS

(21) Have you ever stood a watch or a portion of a watch alone while at-sea?

How often?

Comments:

(22) Have you ever stood a watch at night while at-sea?

How often?

Comments:

(23) Have you ever encountered a crossing situation at-sea?

How many?

Comments:

(24) Have you ever encountered a meeting situation at-sea?

How many?

Comments:

(25) Have you ever planned, or assisted in planning, the approach of your ship into a port?

How often?

Comments:

(26) Have you ever departed or entered a port at night?

How often?

Comments:

(27) On what types of vessels have you had at-sea training experiences?

(28) On what routes were these vessels engaged during your tenure aboard?

(29) Who was your supervisor aboard the vessel during your most recent at-sea training experience (i.e., Chief Mate)?

(30) Rank the quality of instruction that you received from your supervisor aboard the vessel during your most recent at-sea training experience?

0 1 2 3 4 5 6 7 8 9 10

Poor Excellent

Comments

APPENDIX I

ANALYSIS OF STUDENT DEBRIEFING QUESTIONNAIRE AND ESSAY

DEBRIEFING QUESTIONNAIRE

In order to gain insight into the cadet reaction to simulator-based training, a debriefing questionnaire was administered to each cadet upon completion of the Phase 3 training program. An analysis of their response to each question is contained in this appendix. Several key points, however, should be highlighted:

- The cadets perceived that the Phase 3 simulator-based training program was beneficial as evidenced by their own evaluation of their performance. For the rules of the road training, they gave themselves a mean rating of 8.42 on the posttest (i.e., 0 to 10 scale) as compared to only 4.33 on the pretest. For the port approach module, their mean posttest score was 7.42 while their mean pretest score was 6.58.

- One hundred percent of the cadets stated that this simulator-based training course had more practical value than other courses presented by the Nautical Science Department. Although some may view this finding as biased due to the cadets' recent exposure to the simulator-based training, it nevertheless shows their enthusiasm for simulator-based training.

- Ninety-two percent of the cadets stated that they had never stood watch alone at sea, which they did on the simulator. A similar percentage never assisted in planning their ship's approach to port prior to this course. Fifteen to 20 percent of the cadets had not stood watch at night, encountered a crossing situation, or encountered a meeting situation at sea. These findings appear to indicate areas where cadets may not be receiving adequate training or operational exposure. These may be the areas where the simulator, with its high degree of training control, may most practically supplement the existing at-sea training programs.

STUDENT ESSAY

As part of the requirement for this course, each student was required to submit an essay, the main objective of which was to compare at-sea training with the simulator training course. Specifically, each student was to discuss:

- The advantages/disadvantages of both simulator-based training and at-sea training
- Issues or tasks which are better learned or taught on a simulator
- Scheduling of simulator training in the 4-year program

Generally speaking, nearly all midshipmen felt that although simulator training is invaluable, there is no substitute for at-sea, hands-on experience.

The following tasks were determined by the midshipmen to be better acquired or learned on a simulator than at sea:

- Enhancement of decisionmaking skills, particularly in regards to maneuvering
- Development of proper watchkeeping procedures

- Proper helm orders
- Proper use of VHF communications
- Radar plotting in "actual" traffic situations
- Intraship communications

Another question covered the offering of a simulator course within the 4-year curriculum. Although there was some diversity of opinion, all midshipmen believed that a similar course should be offered to all first classmen during their final year and preferably towards the end of the academic year.

A number of students felt that an introductory course covering bridge procedures and protocol should be given during the plebe year with an advanced course in rules of the road and port approach and piloting given during the first class year.

Furthermore, some comment was given concerning other areas or exercises conducive to the simulator. These were:

- Man-overboard exercises
- Emergency procedures such as:
  - Engine breakdown
  - Steering failure
- Reduced visibility
- Night conditions
- High winds
- Unknown currents
- Different ownships, e.g., 250,000 dwt tanker, 125,000 m^3, LNG, and container-ship

STUDENT DEBRIEFING QUESTIONNAIRE

I. Self Evaluation

Question 1: Rank your performance on the rules of the road pretest (0 to 10).
Average = 4.33
Range = 1 to 8

Breakdown

Rating	1	2	3	4	5	6	7	8
Number of students	2	1	2	1	1	3	1	1
Percentage	16.8	8.3	16.7	8.3	8.3	25	8.3	8.3

Question 2: Rank your performance on the rules of the road posttest (0 to 10).
Average = 8.42
Range = 7 to 10

Breakdown

Rating	7	8	9	10
Number of students	2	4	5	1
Percentage	16.7	33.3	41.7	8.3

Question 3: Rank your team's performance on the port approach pretest (0 to 10).
Average = 6.58
Range = 5 to 8

Breakdown

Rating	5	6	7	8
Number of students	2	4	3	3
Percentage	16.7	33.3	25	25

Question 4: Rank your team's performance on the port approach posttest (0 to 10).
Average = 7.42
Range = 2 to 9

Breakdown

Rating	2	5	6	7	8	9
Number of students	1	1	1	1	3	5
Percentage	8.3	8.3	8.3	8.3	25	41.8

II. Simulator Comments

Question 5: Rank the realism of the simulated visual scene during the rules of the road training scenario (0 to 10).
Average = 7.25
Range = 4 to 9

Breakdown

Rating	4	6	7	8	9
Number of students	1	2	2	6	1
Percentage	8.3	16.7	16.7	50	8.3

Question 6: Rank the realism of the simulated visual scene during the port approach training scenario (0 to 10).

Average = 6.67
Range = 4 to 8

	Breakdown				
Rating	4	5	6	7	8
Number of students	1	2	1	4	4
Percentage	8.3	16.8	8.3	33.3	33.3

Question 7: Was the simulated vessel scene adequate for the rules of the road training module?

	Yes	No	Did Not Respond
Number of students	10	1	1
Percentage	83.4	8.3	8.3

Question 8: Was the simulated visual scene adequate for the port approach training module?

	Yes	Did Not Respond
Number of students	11	1
Percentage	91.7	8.3

Question 9: Did the "binocular effect" distract significantly from overall simulator realism?

	Yes	No	Did Not Respond
Number of students	2	9	1
Percentage	16.7	75	8.3

III. Training Program Comments

Question 10: Compare the practical value of this course to the practical value of other courses presented by the Nautical Science Department.

This course more valuable	12	100% (course more valuable)
This course equivalent	0	
This course less valuable	0	

Question 11: Compare the practical value of this course to the practical value of your last at-sea training period.

This course more valuable	3	25%
This course equivalent	8	66.7%
This course less valuable	1	8.3%

Question 12: From which training module did you gain the most practical experience:

	Rules of the Road	Port Approach	Both Equal
Number of students	5	4	3
Percentage	41.7	33.3	25

Question 13: Evaluate the length of the classroom sessions.

Too long	2	16.7%
About right	9	75%
Too short	1	8.3%

Question 14: Evaluate the length of the simulator sessions.

Too long	0	0%
About right	8	66.7%
Too short	4	33.3%

Question 15: Rank the overall training program organization (0 to 10).
Average = 8.92
Range = 8 to 10

Breakdown

Rating	8	9	10
Number of students	5	3	4
Percentage	41.7	25	33.3

Question 16: Rank the professionalism of the instructors (0 to 10).
Average = 9.67
Range = 9 to 10

Breakdown

Rating	9	10
Number of students	4	8
Percentage	33.3	66.7

IV. Logistical Comments

Question 17: Did you have adequate familiarization on the simulator prior to the rules of the road pretest?

With Bridge Equipment		With Ownship Maneuvering Characteristics	
Yes	No	Yes	No
11	1	10	2
91.7	8.3	83.3	16.7

Question 18: Did the hours at which this course was offered create significant problems for you?

Response	Often	Sometimes	Very Little	Never
Number of students	3	1	3	5
Percentage	25	8.3	25	41.7

Question 19: Would you recommend this course to your friends?

All 12 enthusiastically said "yes" 100%

Question 20: Will you participate in future CAORF experiments if your expenses are reimbursed?

Yes	12	100%
No	0	

V. Practical Experience Comments

Question 21: Have you ever stood a watch or a portion of a watch alone while at sea?

Yes	1 (employed on a deep-sea tug)	8.3%
No	11	91.7%

Question 22: Have you ever stood a watch at night while at sea?

Results 10 responded "yes"
2 responded "no"

Note The 10 who responded "yes" were asked "how often?"

17%	0 to 10 night watches
8%	11 to 20 night watches
17%	over 20 night watches
33%	numerous
25%	no specific number
Range	0 to 30

Question 23: Have you ever encountered a crossing situation at sea?

Results 10 responded "yes" 83.3%
2 responded "no" 16.7%

Note The 10 who responded "yes" were asked "how many?"

50%	0 to 10 crossing situations
17%	few crossing situations
25%	numerous crossing situations
8%	over 20 crossing situations
Range	to 40

Question 24: Have you ever encountered a meeting situation at sea?

Results	10 responded "yes" (83.3%)	
	2 responded "no" (16.7%)	
Note	The 10 who responded "yes" were asked "how many"?	
	50%	0 to 10 meeting situations
	8%	over 20 meeting situations
	8%	very few meeting situations
	25%	numerous meeting situations
	8%	did not know
	Range	0 to 40

Question 25: Have you ever planned or assisted in planning the approach of your ship into a port?

Results	1 responded "yes" (8.3%)
	11 responded "no" (91.7%)
Note	The "yes" respondent indicated having assisted five times in a port approach plan.

Question 26: Have you ever departed a port at night?

Results	All 12 responded "yes" (100%)	
	25%	0 to 10 night departures
	35%	11 to 20 night departures
	8%	over 20 night departures
	25%	numerous night departures
	8%	no specific number
	Average	approximately 15 times
	Range	5 to 30 times

Question 27: On what types of vessels have you had at-sea training experiences?

Tanker	5	41.7%
Break-bulk/freighter	12	100%
Containership	9	75%
Tug	3	25%
Lash/seabee	5	41.7%
Great Lakes carrier	3	25%
Other (supply boat)	1	8.3%

Question 28: On what routes were these vessels engaged during your tenure aboard?

South and East Africa	1	8.3%
West Africa	3	25%
Mediterranean	6	50%
EC U.S., Caribbean	5	41.7%
WC U.S., Alaska and Hawaii	7	58.3%
Far East	4	33.3%
Gulf Coast	2	16.7%

India	2	16.7%
N. Europe	5	41.7%
Australia	1	83%
Great Lakes	2	16.7%
South America	7	58.3%

Question 29: Who was your supervisor aboard the vessel during your most recent at-sea training experience (e.g., chief mate)?

Master	2
Chief officer	10
2nd officer	1
3rd officer	1
Boatswain	1

Note: Some midshipmen had more than one supervisor.

Question 30: Rate the quality of instruction that you received from your supervisor aboard the vessel during your most recent at-sea training experience (on a scale of 0 to 10; poor to excellent).

Average = 7.3
Range = 5 to 9

Breakdown

Rating	5	6	7	8	9
Number of students	3	1	2	1	5
Percentage	25	8.3	16.7	8.3	41.7

APPENDIX J

SUBJECT DEMOGRAPHICS

The following survey of the cadets involved in the second cadet experiment provides an overview of the cadets' areas of residence; age range; previous college, merchant marine, and military experience; as well as a summary of their academic record and courses of study.

AREAS OF RESIDENCE

The following three geographic areas were used to establish the cadets' area of residence (i.e., birthplace): (a) east coast, (b) mid-west (Great Lakes), and (c) west coast. As can be seen in Figure J-1, 58.3 percent of the subjects were from the east coast, 25 percent resided in the mid-west (Great Lakes), and 16.7 percent were from the west coast.

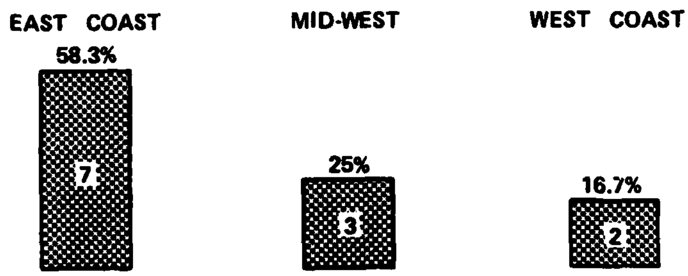


Figure J-1. Area of Residence

AGE OF SUBJECTS

The age range of cadets was from 22 to 26 years, with the average age being 22.9 years. As indicated in Figure J-2, 58.3 percent of the cadets were age 22; 16.8 percent were 23 years of age; 8.3 percent were 24; 8.3 percent were age 25; and 8.3 percent were 26 years of age.

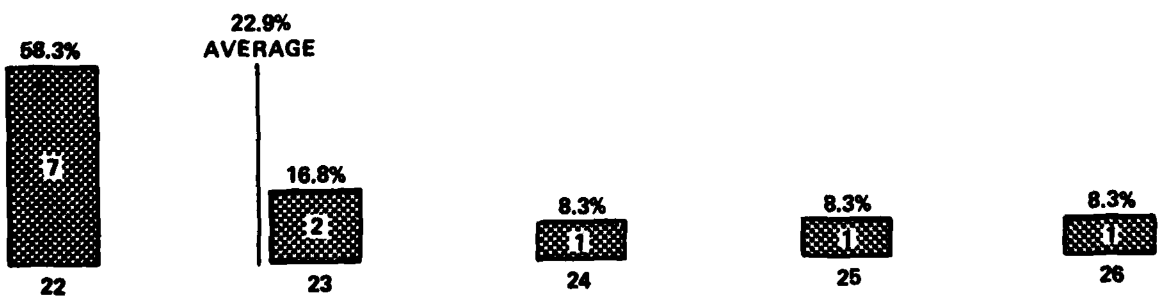


Figure J-2. Age of Subjects

PREVIOUS EXPERIENCE

The category of previous experience was divided into three segments: (a) prior merchant marine experience, (b) prior college experience, and (c) prior military experience. None had prior merchant marine experience; 33.3 percent of the cadets had prior college experience, ranging from 1 to 3 years; and only 8.3 percent (one cadet) had prior military experience.

ACADEMIC RECORD

The following three items provide a summary of the cadets' academic record: (a) 4-year academic average (quality point average), (b) class standing (percentile), and (c) academic average for the quarter preceding this course.

Overall Quality Point Average (QPA)

The cadets' overall QPA ranged from 2.20 to 3.87, resulting in an average QPA score of 3.0. Figure J-3 divides this range into four segments: (a) 2.20 to 2.50, (b) 2.51 to 3.00, (c) 3.01 to 3.50, and (d) 3.51 to 4.0.

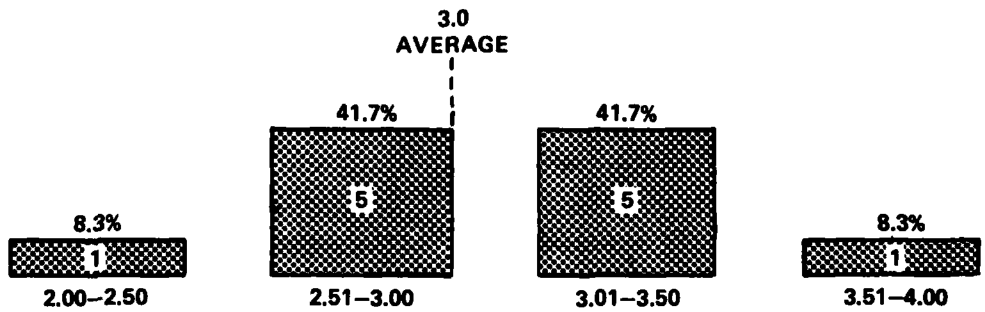


Figure J-3. Overall QPA

Class Standing (Percentiles)

The cadets' class standings ranged from the 99th percentile down to the 23rd percentile. Of the 10 students responding, one student was at the 99th percentile; three students were in the 80th to the 90th percentile range; three students were in the 70th to the 79th percentile range; and three students' standings were below the 50th percentile. See Figure J-4.

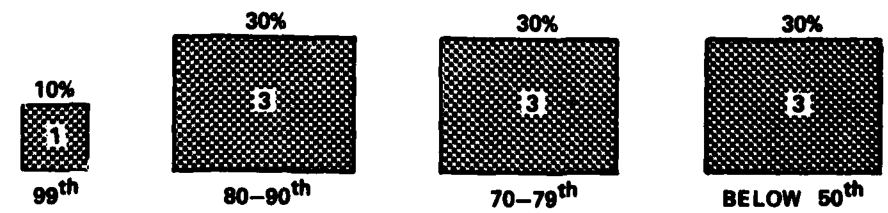


Figure J-4. Class Standing (Percentiles)

QPA of Quarter Preceding Course

The cadets' QPA for the quarter completed prior to taking this course ranged from 2.0 to 4.0 with a 3.1 average QPA. Figure J-5 divides this range into four segments: (a) 2.00 to 2.50, (b) 2.51 to 3.00, (c) 3.01 to 3.50, and (d) 3.51 to 4.0.

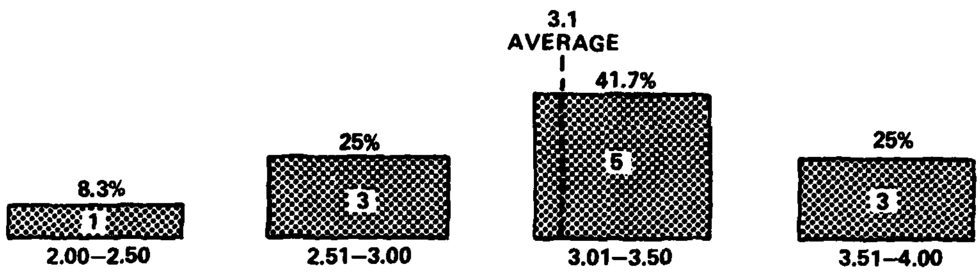


Figure J-5. QPA of Quarter Preceding Course

COURSES OF STUDY

While 91.7 percent of the cadets who participated in this course were majoring in Nautical Science, the remaining 8.3 percent were majoring in Marine Transportation. Twenty-five percent of the cadets had participated in the small vessel operations course.

BIBLIOGRAPHY

Aranow, P., Hammell, T.J., and Pollack, M. Rules of the Road Training Investigation. U.S. National Maritime Research Center, Kings Point, New York, 1977.

Convention on the International Regulations for Preventing Collisions at Sea (COLREGS), 1972.

Hammell, T.J., Gynther, J.W., Grasso, J.A., and Gaffney, M. Simulators for Mariner Training and Licensing Phase 2: Investigation of Simulator Characteristics for Training Senior Mariners. U.S. National Maritime Research Center, Kings Point, New York (expected to be published in 1981).

Hammell, T.J., Gynther, J.W., Grasso, J.A., and Lentz, D.C. Simulators for Mariner Training and Licensing Phase 2: Investigation of Simulator-based Training for Maritime Cadets. U.S. National Maritime Research Center, Kings Point, New York (expected to be published in 1981).

Hammell, T.J., Williams, K.E., Grasso, J.A., and Evans, W. Simulators for Mariner Training and Licensing Phase 1: The Role of Simulators in the Mariner Training and Licensing Process. U.S. National Maritime Research Center, Kings Point, New York, 1980.

Inter-governmental Maritime Consultative Organization (IMCO). International Convention on Standards of Training, Certification, and Watchkeeping for Seafarers, 1978.

Maloney, Elbert S. Dutton's Navigation and Piloting, Thirteenth Edition. Naval Institute Press, Annapolis, Maryland, 1978.

Operations Research, Inc. Study of Task Performance Problems in Reports of Collisions, Rammings, and Groundings in Harbors and Entrances. Prepared for the U.S. Coast Guard, Washington, D.C., November 1978.

Public Law 95-474. 95th Congress. Port and Tanker Safety Act of 1978.

*U.S. GOVERNMENT PRINTING OFFICE: 1982 522-046/8483 1-3

DATE

FILMED

8